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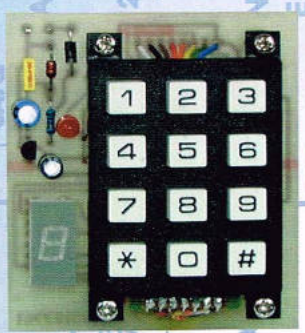

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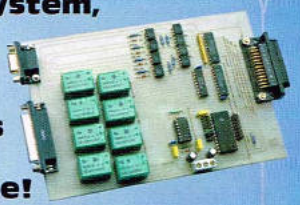

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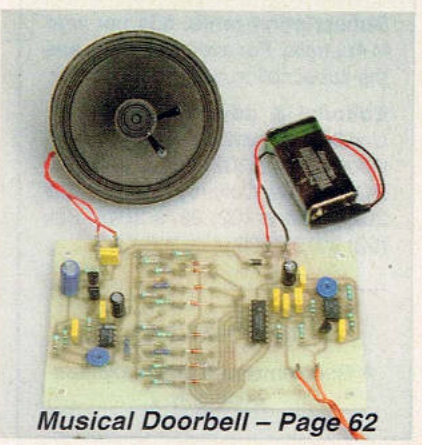

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PUBLISHER'S LETTER

EMC regulations a disadvantage for Australia

Over the last year or so there has been considerable anguish in the Australian electronics industry over the complexity and costs of complying with the new EMC standards. In essence, these EMC (Electromagnetic Compatibility) regulations appear to have been introduced with little consultation with industry. If there had been widespread consultation, the overwhelming reaction would have been that we don't want or need these regulations.

The real problem with these regulations is that they closely follow the European standards which appear to have been framed to make it as difficult as possible for countries outside Europe to get their products in.

If Australia was a major exporter of electronic and electrical products to Europe there might be some point in adopting these standards but we're not. And those Australian manufacturers who do export to Europe will automatically comply with European standards anyway.

This is the same story as with the proposed reduction of mains voltage in Australia from 240VAC to 230VAC. We wrote about this in the April and May 1994. That will still happen by the way but there will be no benefit to Australia, only costs.

What's in the new EMC regulations for Australian consumers? As far as we can see, very little. All electrical and electronic products being sold in Australia now must comply with the new standards and that means that they will either be dearer than they otherwise would have been or they will be withdrawn from sale, to avoid the costs of compliance. In the meantime, big and small Australian companies, whether they are exporting or not, still must bear the costs of compliance.

There is also some anecdotal evidence that imported products which supposedly do comply with the standards actually produce quite high levels of interference. However, it seems that the bureaucrats are more interested in checking the paperwork to see that products have been approved than whether approved products actually produce interference. That stands to reason, doesn't it? Their thinking would be, "If it's approved, it must be OK".

By the way, I am all for EMC regulations but we don't need the draconian regulations we have now. And nor, interestingly enough, does the USA. They have not moved to meet European standards and why should they? They have their own set of regulations set by the FCC and other bodies and they are quite adequate. And so were our previous standards but they were not enforced.

I believe that ultimately the whole process of EMC enforcement is in danger of falling into a heap. Unless the Spectrum Management Authority, now merged into Australian Communications Authority, has the staff to actually check that approved products radiate low levels of interference or are not subject to interference, then there is not much point in having the regulations in the first place.

In fact, it is highly likely that the ACA does not have enough staff to even check that all the electronic and electrical products being sold in Australia actually are backed with the paperwork to show they comply. To do so, they will need to audit each and every business in Australia involved in importing, distribution or retailing. That's an enormous task.

The big problem for Australia in all this is that there are not enough organisations or individuals in Australia who are willing to speak out against these initiatives when they are first mooted. We spoke out against the initiative to reduce the 240VAC mains voltage but the response was a big yawn. Well, Australia will pay dearly, just as we will for these EMC regulations.

If you want to find out more about EMC you can check it out on the Internet at http//www.aca.gov.au

Leo Simpson

MAILBAG

Upgrading a 486

I recently had the experience of installing AMD 5x86-133 CPUs in two 486 motherboards, one a Chicony brand, the other a Biostar with a UMC chipset, neither of which was designed with a 586 CPU in mind. The AMD 5x86-133 CPU can be made to work in a motherboard not specifically designed for it by jumpering it as per an AMD DX4-100 "plus" or "enhanced" CPU; ie one with power management functions. Jumpering it as a plain AMD or Intel DX4-100 will not work. Choose a 3.45V supply voltage and a 33MHz CPU clock.

At this point the BIOS will identify the CPU as an AMD DX4 running at 100MHz. For the CPU to run at its rated 133MHz, a "clock multiplier" jumper must be set. Look for a jumper whose function is "jumper open = 3x clock, jumper closed = 2x clock". A Biostar manual describes this jumper as "DX/DX4 open, DX2 closed". A DX4-100 CPU can run (internally) at either 3x or 2x the motherboard clock. Normally the bus clock is set to 33MHz, and the CPU clock = 3x 33 = 99MHz. I suppose one could use a bus clock of 50MHz and CPU clock = 2x 50 = 100MHz. I suspect that the latter combination would result in faster I/O (eg, faster graphics and disc I/O) at the same internal CPU speed. I haven't tried this, though.

A 5x86-133 CPU uses a clock multiplier of either 3x or 4x. In this case, the jumper described above has a slightly different meaning. An open jumper selects a 3x clock as before (99MHz), but a closed jumper selects a 4x clock (133MHz). This jumper may take some finding. For those with a multimeter, one side of this jumper is connected to earth, the other to pin R-17 (CLKMUL) of the CPU. When correctly set, the BIOS sees the CPU as an AMD DX4 "plus" running at 4x 33 = 132 MHz. Be sure to enable write-back mode for the internal CPU cache (16K).

I wonder if a system using a clock-doubled 486DX4-100 CPU on a 50MHz bus (assuming this were possible) would be faster than the same system using a 5x86-133 CPU on a 33MHz bus? What about a 586-133 running at 120MHz in clock tripled mode on a 40MHz bus?

F. Zabkar,
Barrack Heights, NSW.

Video security sign has a drawback

I have just read the Video Security article on page 62 of the September edition of SILICON CHIP. I feel that anyone contemplating using the sign on page 67 should consider the following scenario.

Having just burgled your neighbour's home, burglars about to burgle yours are confronted by this sign. **Now they must burgle your home** in order to retrieve the tape linking them with the neighbour's burglary. If after ransacking your home they are unable to locate the tape, their options are limited, one being to **torch your home** in order to destroy the evidence.

A safer solution for a low security site such as a home is a sign that reads: "This property is under VIDEO SURVEILLANCE with Off-Site Recording".

Any VCR used for recording should be well-hidden. If the power meter box is not secure, then a UPS (low cost computer type may be adequate) should be used to power the VCR, cameras, etc. Although probably unnecessary for a home but certainly of value for shop and business surveillance is a dummy VCR complete with tape placed in a prominent position. This tape may be easily taken by or handed over (under threat) to a burglar.

K. Forknall,
Northlands, WA.

Backing up is important

Referring to your editorial in the July 1997 issue of SILICON CHIP, I think you hit the nail right on the head. Many people don't even think of or are even told about backups. This could be due to the view of sales people assuming that the purchaser will only use the machine for trivial or unimportant tasks; eg, playing games.

In many cases the machine will work OK for a long period of time but one day it may play up. What's the next step? – try to find what's caused the corruption and get a backup disc out and restore the corrupted files. If you don't have a backup the data is unrecoverable and you'll never see it again. Even with disc repair utilities such as Norton's this will not guarantee to get any or all of your data back!

I recently purchased a backup tape drive for my machine to complement an already numerous set of backup floppy discs. Despite this, a couple of months ago I lost a file due to corruption and ended up recreating it from a printout because the corruption had unknowingly been saved and both machine and floppy had the corrupted file. You can never be too cautious!

S. Sidoti,
Lilyfield, NSW.

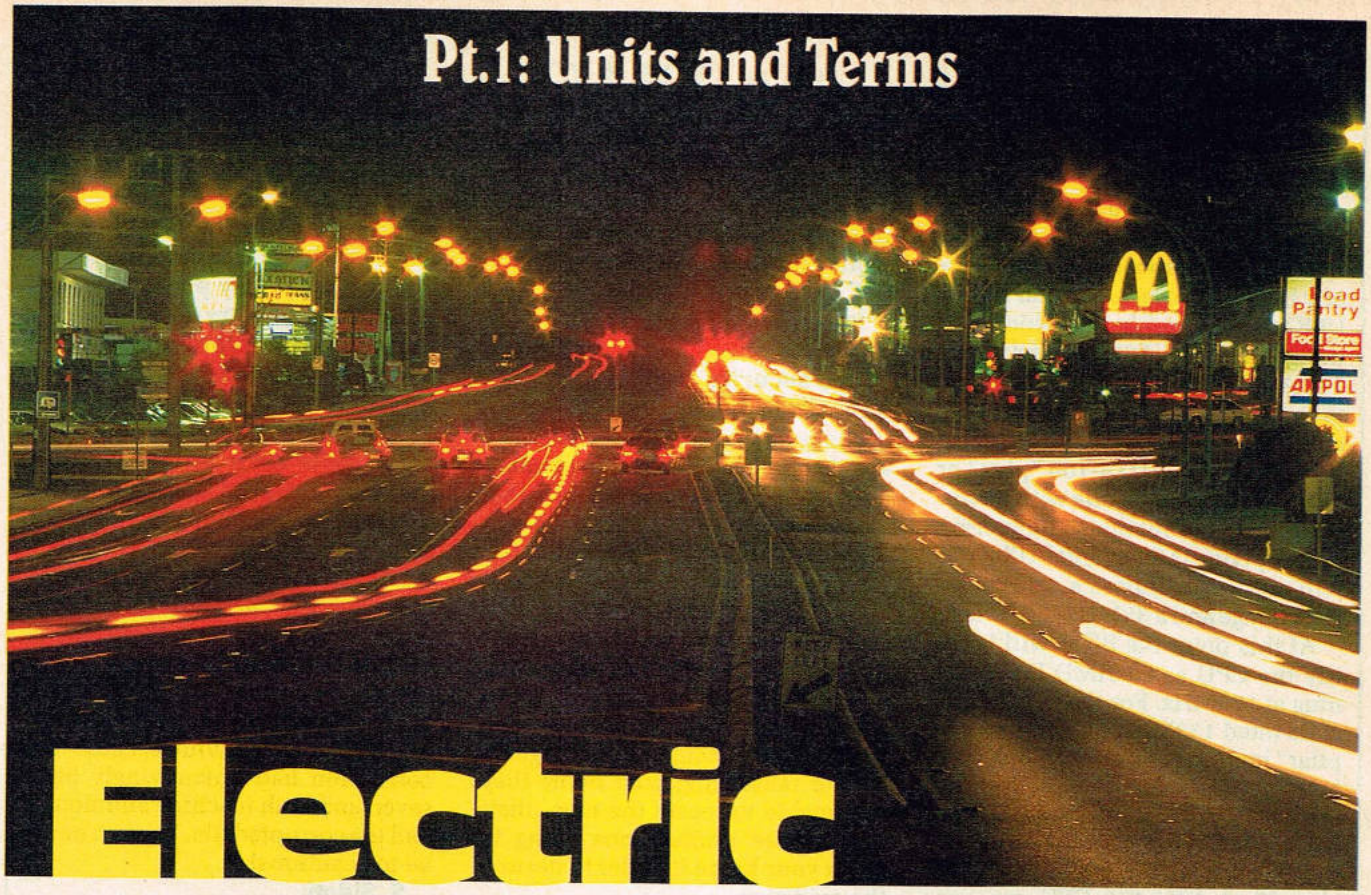
Burst charging does the job

I have been evaluating Nicad Battery Charger designs lately with the intention of building two permanent installations for domestic use. Two articles from SILICON CHIP have been brought to my attention, these being in the May 1994 and October 1995 issues. Both these featured projects using the Philips TEA 1100 IC which, if I have read and understood both articles correctly, rely on "Delta V" voltage detection to terminate normal charge mode and progress to trickle charge.

The reason I mention these two articles is that I have also read the excellent article by Horst Reuter from Smart FastChargers in the January 1996 issue of SILICON CHIP. In his article he mentions that he is of the opinion that once the charge voltage peak is reached and the voltage levels out, any nicad battery still charging in the normal charge mode and which reaches the point where the voltage starts to drop (the "Delta V"

continued on page 7

Pt.1: Units and Terms



Electric Lighting

In this new series on electric lighting, we will look at the different types of lights available and describe how they work. But let's first examine the basic units and terms.

By JULIAN EDGAR

Looking around as you travel at night through city streets, you can't help but wonder at all the different lights. Bright yellow street lights, white fluorescent tubes positioned behind glowing signs, small intensely bright lights used in shop displays – they all use different technology to turn night into day. Like most technology, we tend to take the presence of electric light for granted – until the power goes off or a blown lamp makes our car a one-eyed monster.

But did you know that the output of a fluorescent tube decreases at lower temperatures, or that more infrared energy than visible light is emitted by the humble light bulb? That the pressure of the gas inside a light bulb changes as it gets hotter? That it's not just your imagination that objects change colour under different lights? That excess lighting in offices places a large load on the airconditioning equipment? That not cleaning lights can effectively decrease their output by 25% after a few years?

In this series we will answer questions like these and also examine all of the common types of electric lighting used. There's certainly a lot more to it than initially meets the eye and that includes answering an apparently simple question – how do we describe the amount of light produced by a lamp?

Luminous intensity

Luminous intensity is measured in

Candela (cd) in both the imperial and metric systems. The origins of the unit can be directly traced back to candles made of whale fat.

In 1860, a unit of luminous intensity known as the "candle" was established. This used, as the base standard, a candle made from a specific quantity of sperm whale fat burning at a specified rate. Later gas flames also used this unit, with a then-typical gas flame having a luminous intensity of 16 candles. Early incandescent lights had a luminous intensity of a similar magnitude!

In 1909, the candle was redefined in terms of a group of carbon filament incandescent lamps having precise filament dimensions and operating with a defined voltage. By 1937, the definition included a blackbody radiator which at the temperature of solidification of platinum had a luminous intensity of 60 candles per square centimetre. In 1948, the unit was renamed the candela and in 1979 its definition was changed to involve the radiation of light of a single wavelength at a precise power.

As an example of a real world use, luminous intensity is used to describe the amount of light emitted in selected directions from lamps and fittings. Fig.1 shows an example of the intensity distribution of a 150 watt PAR ("Portaflood") bulb.

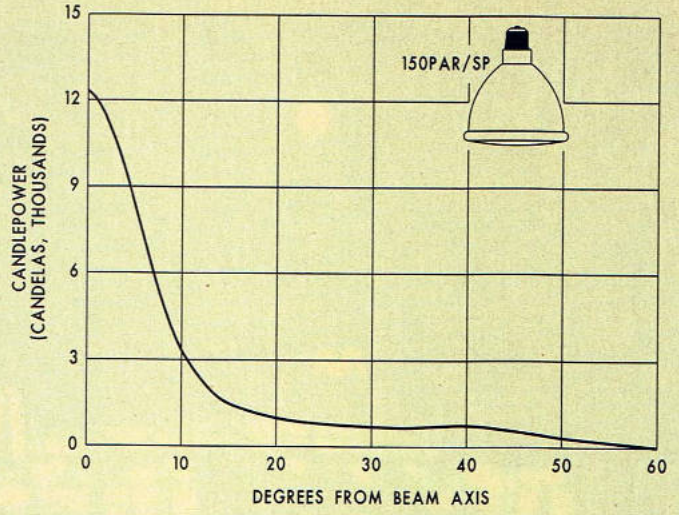


Fig.1: the luminous intensity distribution of a PAR-type 150W bulb. Luminous intensity is measured in candelas. Here it can be seen that directly in line with the beam axis, the bulb has an intensity of 12,000 candelas, falling off to only 1,000 candelas at 20° to the tightly-focused beam. (Murdoch, B. Illumination Engineering).

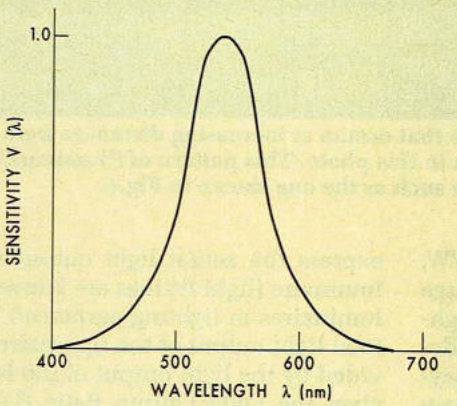


Fig.2: the eye is most sensitive to light with a wavelength of 550 nanometres (yellow-green light). At wavelengths either side of this, the sensitivity falls rapidly. At 450nm (violet), the sensitivity of the eye has typically dropped by over 96%! This change in sensitivity must be taken into account when measuring luminous flux. (Murdoch, B. Illumination Engineering).

Luminous flux

Luminous flux is measured in lumens, which is abbreviated to lm. Just as there is an electrical power input measured in watts, there is a "light power" output measured in lumens. The reason that "light power" is not measured in watts is because the response of the eye to different colours needs to be taken into account.

The part of the radiation spectrum that we can see lies between wavelengths of 380 nanometres (blue) and 780 nanometres (red). While an instrument designed to measure radiation power will read the same at all wavelengths (assuming equal power across the spectrum), the eye has varying sensitivity to different wavelengths.

A close light source producing one watt of radiation at 555nm (yellow-green light) gives a very strong sensation of light because the eye is very sensitive to this wavelength. However, at wavelengths either side of 555nm, the sensitivity of the eye rapidly decreases, as shown in Fig.2.

This means that expressing the light power output in watts is not helpful – if the light power is at a wavelength that we can barely see, then even kilowatts of light power may be useless for practical illumination. Instead, to obtain a measure of the luminous flux of a light, the radiant flux (measured in watts) is weighted by the frequency response curve of the eye. This means that if the light emits a great deal of radiation at 555nm, its lumen rating will be high.

Conversely, if the light radiates at a wavelength to which the eye has a low sensitivity, it will have a low luminous flux value even if the radiated power is quite high.

The lumen is therefore a unit based on human response and cannot be defined as a purely physical quantity, as can the watt. Interestingly, individual response curves often differ from the typical curve shown in Fig.2. That means that my 5 lumens may not be quite the same as your 5 lumens!

Luminous flux measurements are widely used in lighting. A typical application is in expressing luminous efficacy, a measurement of how much light output there is for a given electrical power input. It is expressed in lumens/watt, abbreviated to lm/W.

A typical incandescent light bulb

Above: the reduction in illuminance that occurs at increasing distances from directly beneath a lamp can be seen in this photo. This pattern of illuminance can be plotted on an isolux diagram such as the one shown in Fig.4.

has a luminous efficacy of 8-17 lm/W, while a low pressure sodium discharge lamp (the yellow ones used for highway lighting) has a vastly better efficacy of 100-200 lm/W. If you were paying the electrical bill (and ultimately you are), which one would you use to light a highway?

Another use of luminous flux is to express the actual light output of a luminaire (light fittings are known as luminaires in lighting parlance.) The total light output of the luminaire divided by the light output of the lamp gives the Light Output Ratio (LOR). The LOR of a fluorescent luminaire can be increased by up to 40% by the use of high quality reflectors, compared with the traditional white painted backing plates.

Location	Maintained Illuminance (Lux)
Instrument assembly	1500
Garment manufacture - sewing	750
School classroom	500
Cinema auditorium	50
Kitchen work areas	500
Hospital ward at night	1
Operating theatre (local lighting)	100,000
Toilets	100
Supermarket	750

Fig.3: the CIE recommended illuminance levels for various activities. (Philips Lighting Manual).

Illuminance

Illuminance is expressed in lux, abbreviated to lx and is a measurement of how many lumens there are per square metre. There are recommended values of maintained illuminance for various activities, with Fig.3 showing some International Commission on Illumination (CIE) suggestions. Because of the drop in illuminance as lamps age and luminaires get dirty, "maintained" in this context refers to the actual illuminance obtained with regular maintenance.

On a flat outside surface where there are few reflections, it is quite easy to plot lines of equal illuminance. These lines are called isolux contours and a typical isolux diagram is shown in Fig.4. Basically, it is a diagram of the "pool of light" found beneath outside street lights – the one so beloved of writers of detective fiction!

Such a diagram is useful when designing the lighting system of a car park, for example. The pattern of illuminance shown by the diagram can be clearly seen in the photograph of the McDonald's car park (above), which

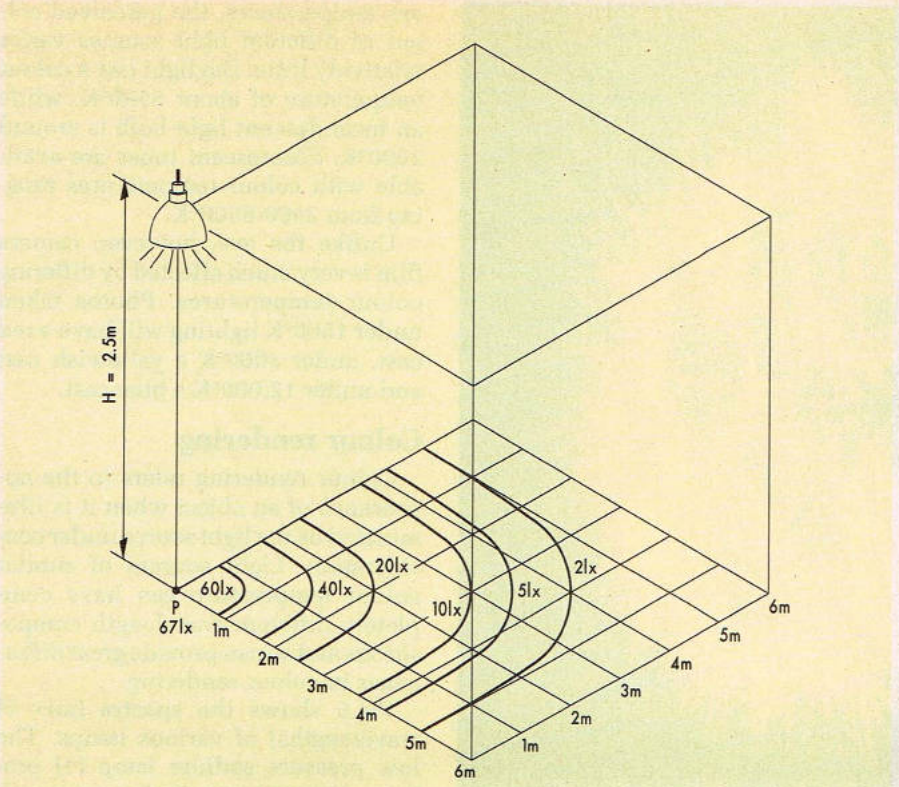


Fig.4: an isolux diagram shows lines of equal illuminance, as would be found beneath a single light illuminating a car park, for example. (Pritchard, D. Lighting).

The colour distribution of a light source can be directly examined with a spectrometer, which uses a prism to split the light into its different colours.

is illuminated mainly by a single light source.

Colour temperature

An object at any temperature will emit radiation. At low temperatures, the wavelengths of the radiation are mostly in the infrared region and so cannot be seen. However, if the temperature of the object is increased, that object (eg, a piece of steel) will start to glow (ie, it begins emitting radiation that can be seen). The temperature of the object can be measured in degrees Kelvin (K), which is its temperature in degrees Celsius plus 273.15.

The radiation properties of a hypothetical so-called black body radiator mean that it will be red at 1000°K,

Mailbag : ctd from p.3

detection point) has already entered the "over charge" mode.

This, he points out, is not desirable for long battery life. He also mentions that it is desirable to utilise some form of alternate charge and discharge, especially if one is charging at the fast charge rate; ie 1C.

I must mention at this stage that I have had one of Horst Reuter's fast chargers and have found that it has done wonders for cells and batteries which had become marginal for a variety of reasons and it is fast reaching the point where it has just about paid for itself. I would be very interested to hear your views on the points which I have raised.

I do look forward to reading the many interesting articles which appear in SILICON CHIP each month.

M. Fraer,
New Zealand.

Comment: the licensed technology used by Smart FastChargers does appear to be effective. What more can we say?

TENS electrodes not easy to obtain

I am writing to let you know of an experience that I have just had with your TENS kit, that you might want to pass on to your readers. I had a friend who wanted one made so I decided to purchase a kitset. The kitsets themselves are very hard to find. I had to ring around several Dick Smith Electronics stores before locating one. The kit itself is great. It is the electrodes that are the real problem. Your article states that the electrodes are available from most chemists.

Unfortunately, that may not be entirely accurate. I tried over eight chemists in Sydney, none of whom had stocked them for at least six months. Only one chemist was able to provide details of where to get them. They can be bought from Masters Medical, 8 Palmer St, Parramatta, NSW 2150. Phone 02 9890 1711. They are about $15-$20 for a pair.

J. Cowan,
No address supplied.

Photos taken under different lighting clearly show the effect of varying colour temperature. This photo has a strong yellow cast and was taken under incandescent tungsten halogen lighting with a colour temperature of about 3000°K.

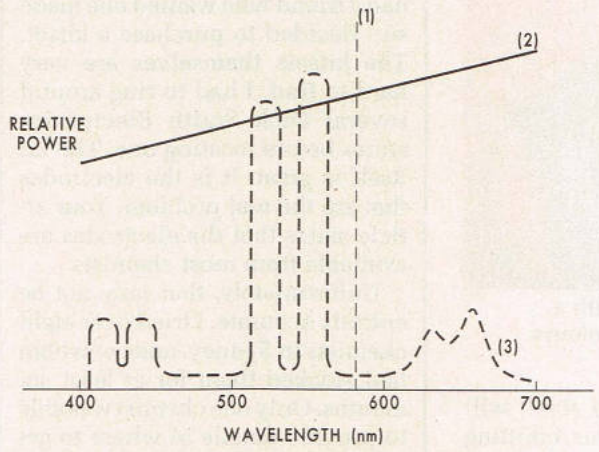


Fig.5: (1) low pressure sodium lamp; (2) incandescent lamp; (3) high pressure mercury vapour lamp. The appearance of colours when illuminated by a lamp depends on the distribution of the wavelengths of light emitted by the lamp. Under a sodium lamp, everything is yellow! (Pritchard, D. Lighting).

yellow near 3000°K, white near 5000°K, blueish white near 10,000°K and pale blue near 30,000°K. This means that the colour of a light source can be specified in terms of its colour temperature. This is the temperature to which a blackbody radiator would have to be heated to match the colour of the light source.

Electric lights have widely varying colour temperatures but because your eyes are very tolerant of differing colour temperatures, the perceived colour of different light sources varies relatively little. Daylight has a colour temperature of about 5500°K, while an incandescent light bulb is around 2800°K. Fluorescent tubes are available with colour temperatures ranging from 2900-6500°K.

Unlike the eye, however, camera film is very much affected by differing colour temperatures. Photos taken under 1500°K lighting will have a red cast, under 3000°K a yellowish cast and under 12,000°K a blue cast.

Colour rendering

Colour rendering refers to the appearance of an object when it is illuminated by the light source under consideration. Light sources of similar colour temperature can have completely different wavelength compositions and so can provide great differences in colour rendering.

Fig.5 shows the spectra (mix of wavelengths) of various lamps. The low pressure sodium lamp (1) produces light at just a single wavelength and so the lamp reveals only that colour. Line 2 shows the spectrum of a incandescent lamp, which has an output that covers all wavelengths fairly evenly – although there is an emphasis on red. A high pressure mercury vapour lamp (3) has a mixture of some 'lines' (high outputs at specific wavelengths) mixed with a continuous background spectrum and a band of energy at the red end. Of these light sources, the incandescent lamp gives the best colour rendering, followed by the high pressure mercury lamp and then the low pressure sodium lamp.

Colour rendering is measured on a colour rendering index (expressed as Ra) scale of 1-100, where 100 provides the best colour rendering. The Ra scale for a lamp is based on the illuminated appearance of 14 different colour chips. These colours include saturated red, yellow, green and blue; and colours approximating the (white) human skin and green foliage. The scale is based on the average colour shift that occurs when changing from the test to the reference illuminant.

The colour rendering of incandescent lights is very good at 99Ra, while fluorescent lights vary from 85-90Ra.

That's all for this month. Next month, we will look at incandescent lamps. SC

Tweak your PC's interface with

Microsoft's PowerToys

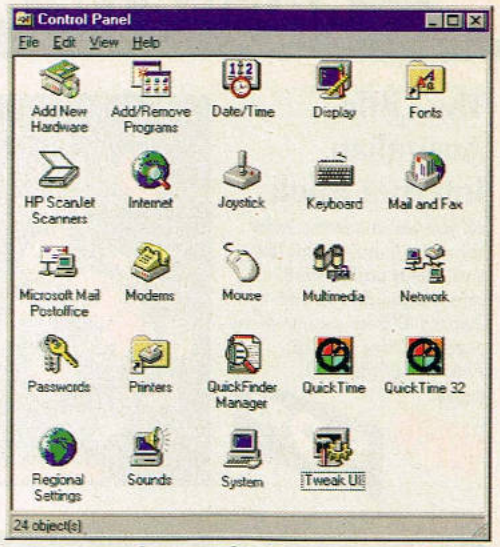


Fig.1: the TweakUI icon is installed in the Control Panel group when you install the PowerToys.

This handy collection of utilities from Microsoft lets you enhance your Windows 95 interface – *By Greg Swain.*

If you don't already have them, the Microsoft PowerToys provide some handy user interface enhancements for Windows 95. These enhancements were developed by Microsoft's Win95 team and you can download them from the Microsoft web site. If you don't have access to the Internet, the PowerToys are often included on the CD-ROMs that come with some computer magazines.

Tweak UI is perhaps the handiest utility in the PowerToys range. Tweak UI stands for "tweak user interface" and when you install the PowerToys, the Tweak UI icon is automatically installed into the Control Panel group.

To quote Microsoft, "Tweak UI is a handy control panel for 'Type A' personalities". Among other things, it can be used to quickly change the boot parameters, including whether or not to automatically start the graphic user interface or stop at the DOS prompt. You can also select an option to automatically display the boot menu and you can choose the length of time that the boot menu is displayed (Fig.2).

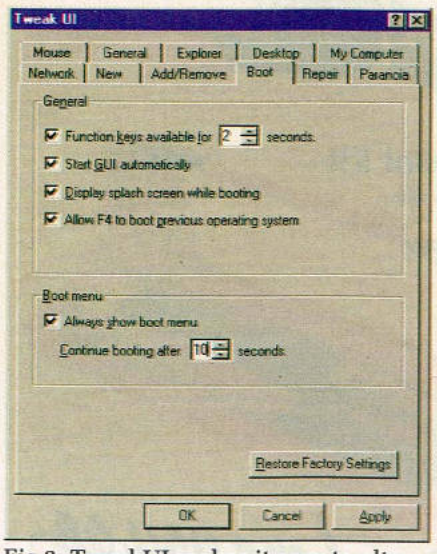

Tweak UI
Mouse General Explorer Desktop My Computer
Network New Add/Remove Boot Repair Paranoia
General
Function keys available for 2 seconds
Start GUI automatically
Display splash screen while booting
Allow F4 to boot previous operating system
Boot menu
Always show boot menu
Continue booting after 10 seconds
Restore Factory Settings
OK Cancel Apply

Fig.2: TweakUI makes it easy to alter the boot parameters. This machine is set to show the boot menu for 10 seconds before booting into Windows.

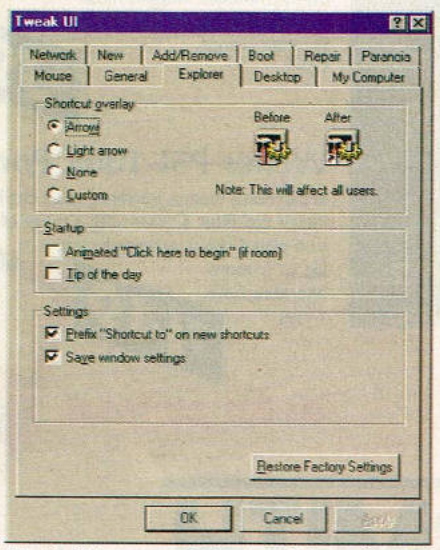


Fig.3: this menu lets you change (or delete) the shortcut arrow and can eliminate that pesky "Shortcut to" preface when you create a shortcut.

This saves you from having to manually edit the MSDOS.SYS file.

Tweak UI also lets you change the appearance of your shortcuts (you can have a smaller arrow or even get rid of the arrow completely) and can eliminate that pesky "Shortcut to" phrase when you create a shortcut (Fig.3). It also lets you set mouse sensitivity and speed and can prevent drive icons from appearing in My Computer.

Another handy PowerToy is the "Cabfile" viewer. For those unfamiliar with the term, the Windows 95 program files are stored on the CD-ROM (or floppies) as compressed files in "cabs". A "cab" consists of a number of compressed files and, on the CD-ROM, is generally about 2.0Mb in size. Normally, you can't use the Explorer to see inside these cab files but with this PowerToy, Explorer treats the cab files as though they were ordinary folders so that you can see the individual files. You can then extract a file from a cab folder simply by dragging it to another folder.

There's lots more to Tweak UI and also quite a few other useful PowerToys, including QuickRes for on-the-fly changes to screen settings (resolution and bit depth) and FlexiCD for controlling audio CDs. The best way to learn about them is to get hold of a copy and install it on your system. **SC**

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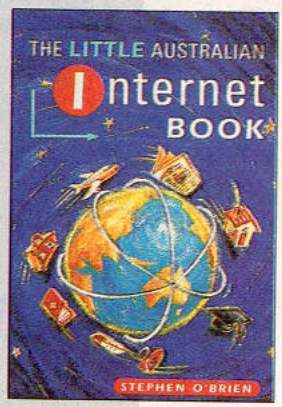

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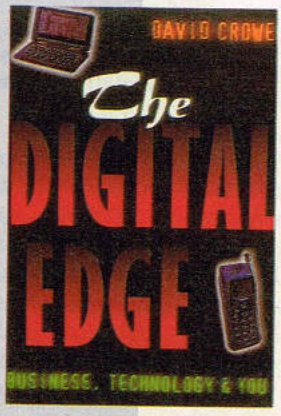

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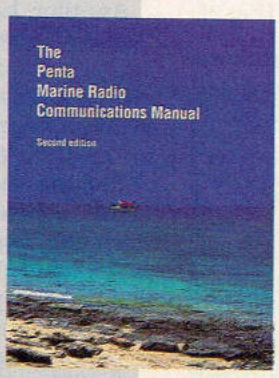

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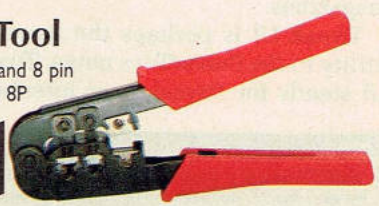

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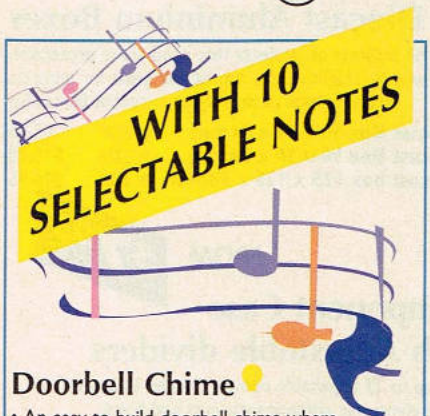

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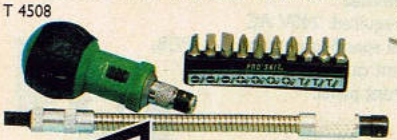

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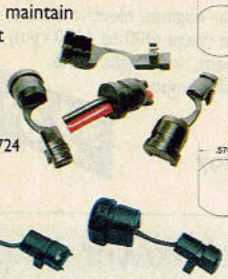

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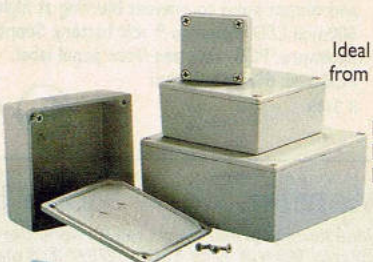

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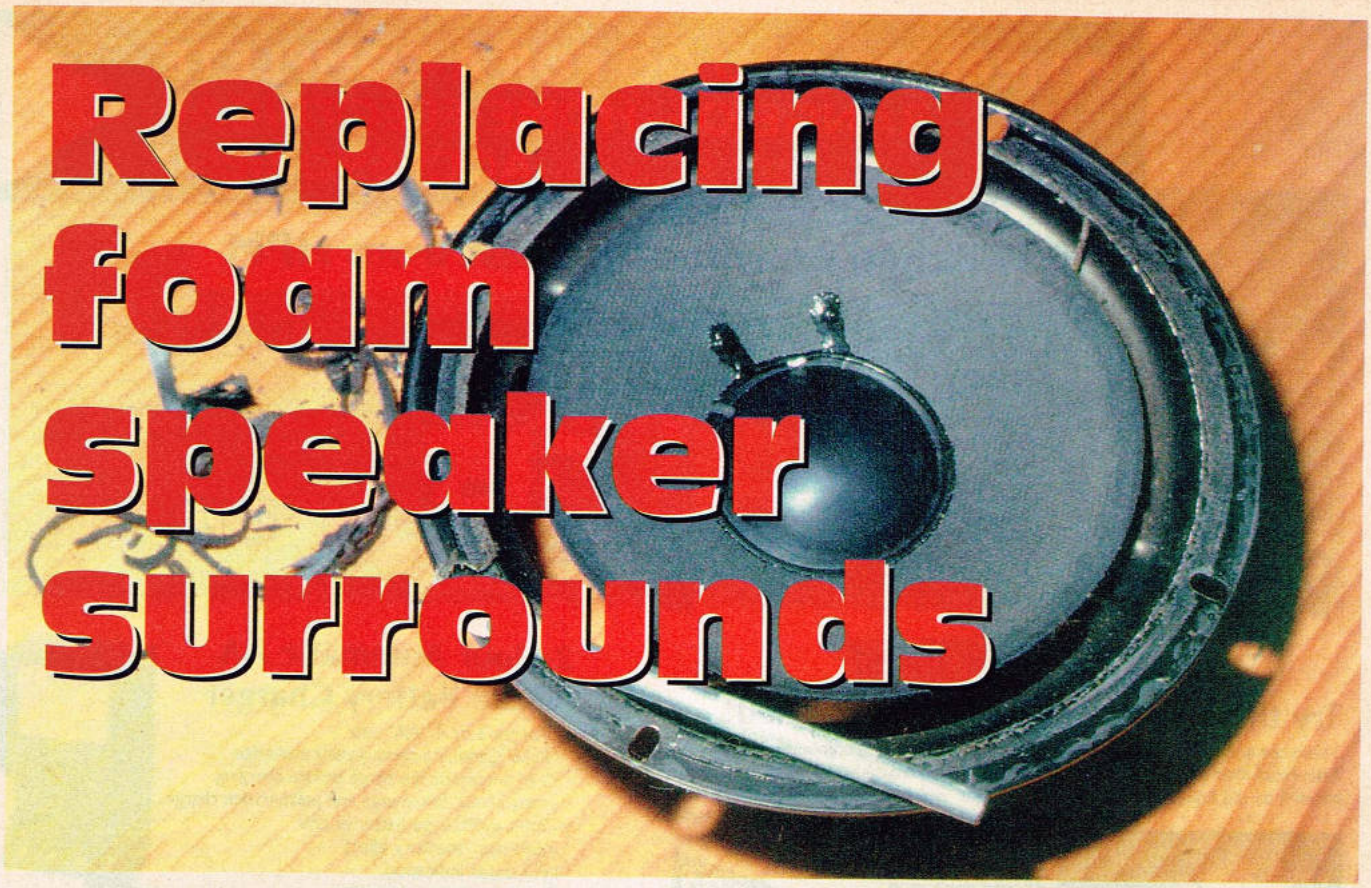
Replacing foam speaker surrounds



. . . just follow this step-by-step procedure

Perished foam speaker surrounds are a common problem for hifi enthusiasts. Unfortunately, replacement drivers are often unavailable or are expensive. Here's a simple step-by-step fix to get things going again.

By BILL HENDRY

This article is in response to a letter published on page 91 of the August 1997 issue, concerning the replacement of perished foam loudspeaker surrounds. Although the answer includes appropriate references to the perils of DIY repairs, the process certainly isn't as onerous or as mysterious as one might infer.

I've been repairing speakers suffering from this complaint for six or seven years now. Although it's not my professional area, I've developed techniques that return the speakers – from 4-inch midranges to 15-inch woofers – to virtually as-new condition. None has failed in this time and owners I've spoken to since have reported normal operation.

As has now become common knowledge, foam-type surrounds, even if "tropic proofed," deteriorate quite quickly. Some become a soggy mess in just two years, particularly in my area, Mackay, on the Central Queensland coast. The most durable compounds appear to be rubber (12-15 years) and impregnated cloth, the latter used on some good Australian speakers.

My technique is well suited to the dedicated home enthusiast. It's inexpensive but does require patience and dexterity. It can be used with all cone materials and the assembly appears to retain its fundamental free-air resonance. However, the four to six hours of work required may not be justified for low-end, plug-in replacement drivers.

The step-by-step procedure is as follows:

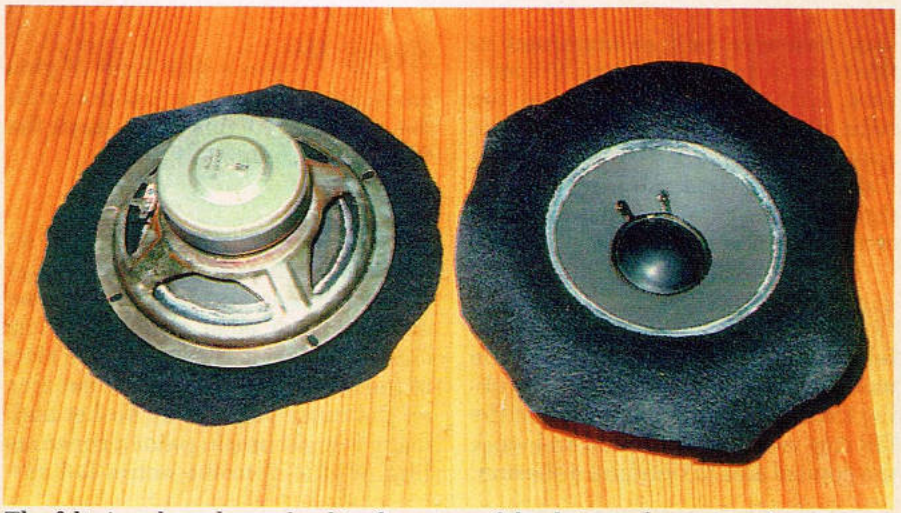
Step 1: check the speaker carefully to ascertain that the cone is in good condition and that the voice-coil is intact. You should also check that

there's nothing in the air-gap to impede normal movement and that the rear suspension "spider" is in good shape. There's no need to cut away the dust cap – in fact, doing so could damage the (now unstable) voice-coil assembly.

Step 2: clean the chassis and cone edge thoroughly, removing all traces of the perished material and any glue. Some models may have dress rings or segments which can be carefully removed and later reinstalled if necessary (although they are usually only cosmetic). I use a hobby knife to scrape away the material but I haven't experimented with solvents.

On a pair of AR 25s that I recently refurbished, the ring of surround material remaining on the edge of the cardboard cone was best removed by carefully pulling it away from the surface towards the edge. This has the effect of also removing a thin layer from the cone material which can later be stabilised by the application of a painted layer of PVA glue (eg, Aquadhere). Other situations may require the careful scraping away of decomposed residue. Inspect the underside of the cone edge to confirm a stable surface that's necessary for the next step.

All traces of the perished material have been removed from the chassis and cone edge of this driver, which is now ready to accept its new felt roll surround. Note the four dress ring segments which have been removed intact – these can later be replaced if desired.



The felt rings have been glued to the cones of the drivers shown here but not yet to the chassis. Note that, in each case, the felt has been glued to the underside of the cone but it can also be glued to the top of the cone if necessary.

Step 3: obtain an appropriate piece of (black) felt from a haberdashery shop. You may not be able to specify density or thickness but the operation doesn't appear to be grade specific.

At this point, determine whether you'd prefer to mount the felt surround replacement on the underside or the upper (visible) side of the cone. (On my last job, a 6-inch Bose Studiocraft midrange, the rear of the chassis was fully enclosed, necessitating attachment of the surround to the upper side). Generally, underside mounting results in a more presentable appearance, allowing for a very neat "dressing" of the join.

Step 4: (delete if you choose Step 7). If the edge of the felt is going to be visible (ie; attached to the upper side of the cone), cut a hole in the felt that's 10-12mm less than the diameter of the cone. This will provide a 5-6mm overlap around the edge of the cone when the felt is in place. The outside of the felt should overlap the edge of the speaker chassis by about 10mm (this will be trimmed later).

You can use a template such as a saucepan lid or a bowl to mark out the felt, which can then be cut using a hobby knife or a pair of scissors.

Step 5: run a bead of PVA glue around the edge of the cone and smooth it neatly to produce a band 5-6mm wide. This done, do the same to the inside edge of the felt ring out to the point of overlap.

Step 6: place the felt ring centrally onto the cone and press it carefully onto the surface. Work the leading edge so that the felt appears "chamfered" at the line of contact with the cone. Paper wedges (eg, loosely crumpled tissues) placed between the cone and the basket will help to keep the cone stable during this procedure.

Step 7: (delete if you chose Step 4): if the edge of the felt is to be attached on the underside, cut out a circle in the felt using a compass, a dressmaker's white pencil and scis-

Once the felt has been glued to the chassis, it can be trimmed by running a sharp hobby knife around the inside of the lip.

sors. Neatness isn't so important in this case, and you won't need to spend time hunting for a template of the right dimension. Apply glue to the appropriate edges as described in Step 5 above. It can be frustrating working through the rear of the chassis, so an artist's brush can be a help.

Step 8: carefully manoeuvre the felt ring over the cone and bring the mating surfaces together. Now, working from the back, make sure that the felt ring is centrally located and work the contact area to optimise adhesion.

Step 9: run a thin bead of glue around the cone at its junction with the felt ring. At this stage leave the PVA to dry completely.

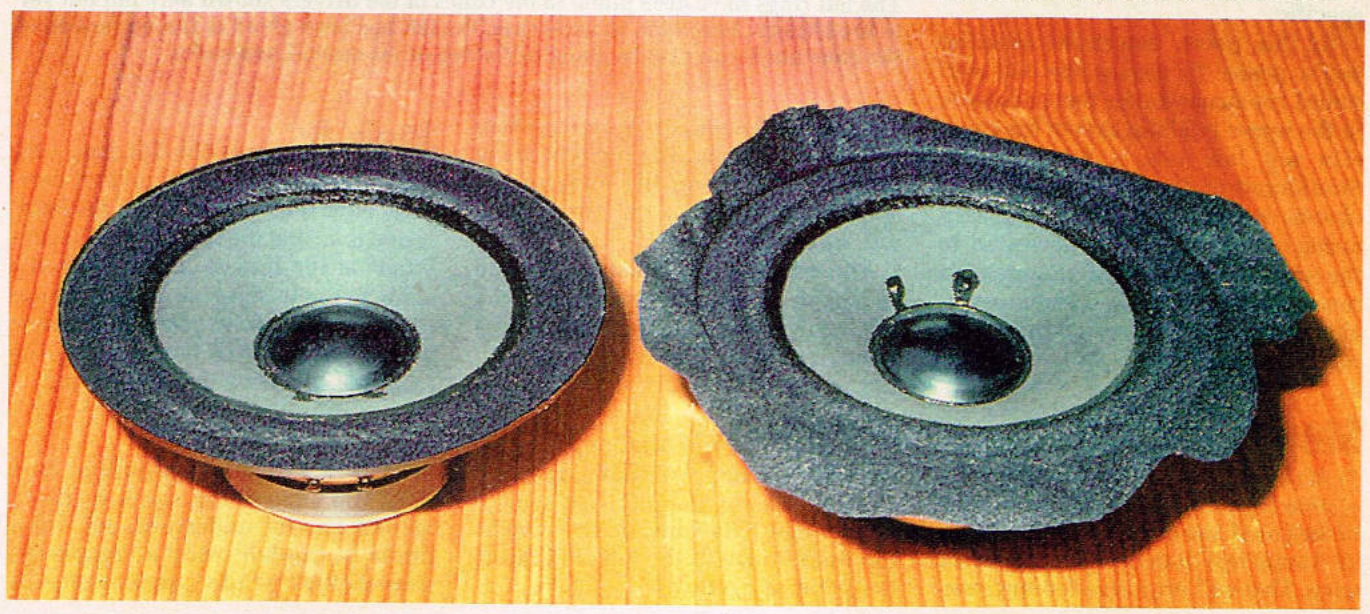
Step 10: lay the speaker on its magnet. You now have the inner edge of the felt ring attached to the cone and the outer edge overlapping the chassis by about 10mm. Lift the skirt of the felt ring to expose the flat area on the outer edge of the basket and, using a small brush, paint a generous film of glue onto the entire flat surface. Do not allow runs to dribble down the supports towards the spider during this procedure.

Step 11: this step is critical. Gently place an upturned glass centrally on the cone (over the dustcap), with sufficient weight to depress the cone to its maximum backward excursion position. This will be indicated by either the former contacting the back of the magnet assembly or the rear suspension spider being stretched to its limit (be careful not to deform it permanently, though). Carefully wiggle the glass up and down and from side to side to make absolutely sure that the voice-coil is centred in the air-gap. It may be necessary to "play" with the assembly to become aware of the tolerances.

Step 12: gently move your hands around the edge of the speaker, working the felt evenly onto the glued surface. This done, use a blunt table knife to create a sharp corner in the felt at the point where the lip is flanged forward.

Step 13: remove the glass and check that the assembly moves freely

Below: the lefthand speaker in this photo has been finished, except for the mounting holes and the optional dress ring segments. Note the "roll" in the felt between the edge of the cone and where the felt attaches to the frame.



to its natural rest position. In so doing, the felt will bulge or dome to form the roll necessary for normal cone travel. Allow the glue to dry.

Step 14: run a hobby knife around the inside of the lip to create a neat invisible edge at the flange. This done, gently lift the cone by applying equal equal pressure to both sides and check that the whole assembly is axially free but radially secure; ie, the cone should move backwards and forwards easily but should not move from side to side.

Step 15: make mounting holes in the felt to align with the holes in the chassis flange. This can be neatly achieved by first gently pushing a hot soldering iron tip right through the felt from the rear at each flange hole position to create a pilot hole. The holes can then be finished by pushing the soldering iron tip through from the front.

Step 16: at this stage, it's time to decide whether you want to replace the dress ring segments. The finished speaker looks quite acceptable without them and, in any case, they may have been damaged during removal. If you do decide to fit them, glue them onto the surface of the felt using a thin layer of PVA but don't let the glue contact the roll. Turn the speaker face down so that its weight is on the dress segments during drying.

Step 17: apply a generous quantity of grease to the felt. Do not use engine grease; instead, use a high-temperature, waterproof compound (eg, Bel-Ray marine grade). This is applied to the felt surround with a fairly stiff-bristled brush, so that the grease is worked well into the fibres (do the whole surround if there's no dress ring). This has the necessary effect of clogging the air-gaps between the fibres but allows the surround to retain its flexibility. It also discourages creatures from making a meal of the felt. If some deformation of the roll occurs during this process, reform it by gently running the handle end of the brush around the underside of the felt.

The result is an attractive, fairly uniform surface that looks quite professional.

The speaker is now ready for use. It's a good idea to feed a very low-frequency sinewave (say 10-20Hz) at low voltage into the voice-coil to check that the cone moves freely before the system is reassembled and played at high volume levels.

Final notes

A few final points are worth noting:

(1) You may feel inclined to paint the entire surface of the (cardboard) cone with PVA to: (a) freshen the appearance, (b) stiffen it, and (c) minimise "grease-creep" across the cone. I don't normally do this to a diaphragm in good condition, in case it significantly alters the cone's mass.

(2) You might consider coating the surround of a new speaker with the abovementioned grease, even if it has been tropic-proofed. I did this with a 10-inch Etone subwoofer foam surround and there's been little change in its appearance after seven years.

(3) Although I've never noticed a problem, you might feel more confident using a non-water based glue, thereby obviating potential corrosion of the metal parts. During the developmental stages of this technique, I used contact glue but there's no room for error – the mating surfaces have to be positioned exactly.

(4) Often the gasket that seals the speaker to the baffle board is damaged, disintegrated or missing. To overcome this problem, I use the Bel-Ray grease to form a continuous ridge at the edge of the baffle-board cutout. The refitted speaker then provides an automatic seal which, if necessary, can easily be broken if the driver needs to be removed.

Finally, please note that although the technique described here generally gives good results, it doesn't restore a driver to its exact original specifications. That's because the compliance of the felt used to make the repair will differ from the compliance of the original foam surround.

The method of attachment will also have some effect on the free-air resonance of the repaired speaker, although its sensitivity will probably be much the same as before.

In the end, it's up to you. If you don't want to fork out big dollars for new drivers, then you've got nothing to loose and you will probably be quite happy with the end result. **SC**

New Foam Surrounds For AR Speakers

On page 91 in the August 1997 issue, G. E. of Armidale, NSW asks about new foam surrounds for AR speakers. I cannot entirely agree with your answer.

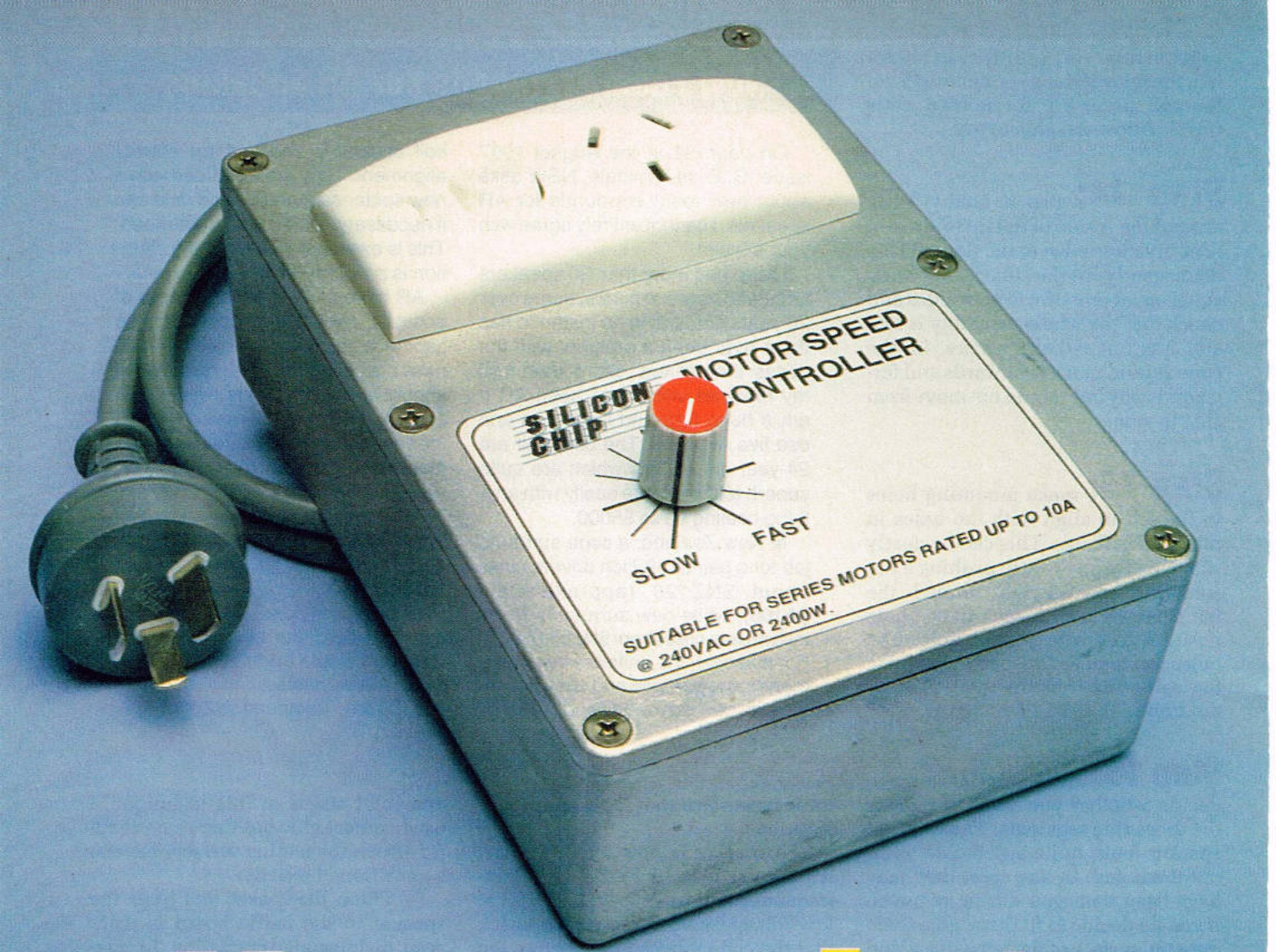
I have had more than 20 speakers fitted with new surrounds, some over 20 years old, and in no instance has there ever been a problem with the cones themselves. More than half my repaired units have been AR (I am a huge fan) and I still own and use five AR pairs. The best pair are 24-year-old AR3a's which are quite superb and compare easily with anything costing up to $5000.

In New Zealand, a cone surround job for a pair of 12-inch drivers costs about $NZ120 (approximately $A100), while new surrounds for 8-inch drivers cost about $NZ85 ($A70). For that cost, the units are inspected (cones, suspension and chassis), fitted with new surrounds and the voice coil assembly checked for correct alignment. They are also fitted with a new spider suspension and dust cap if necessary, tested and guaranteed. This is excellent value and the situation is probably similar in Australia.

AR have always been masters of acoustic suspension speakers, so cabinet size, cone size and air tightness are critical. Your correspondent should stress this to the repairer. Of course, if he can buy new drivers at reasonable cost, then that is a simpler solution. Depending on age, correct drivers may be difficult to obtain. The Australian agent for AR is WC Wedderspoon Pty Ltd, 3 Ford St, Greenacre, NSW 2190. Phone (02) 9642 3993.

If your correspondent requires any help or would like to communicate with me I would be happy to oblige, as an AR enthusiast.

J. Calkin, Takapuna, NZ.



Heavy duty 10A 240VAC Motor Speed Controller

THIS NEW SPEED CONTROLLER can be used with power tools rated up to 10 amps and will give smooth control from zero to full speed. Use it to control the speed of electric drills, routers, circular saws, lawn edgers and other appliances with universal brush-type motors.

Design by JOHN CLARKE

Our last Drill Speed Controller, published in September & November 1992, has been extremely popular and has been used in a host of applications, some of them far beyond what we ever envisaged. But while it is still a valid design, it does have shortcomings.

The first of these is that the maximum speed attainable from the motor is considerably reduced. So for an electric drill which normally runs at say 3000 rpm, the maximum speed might be reduced to around 2200 rpm. This is inevitable with an SCR (silicon controlled rectifier) since the controller circuit effectively half-wave rectifies the 240VAC mains sinewave to give a maximum output voltage of around 160 volts RMS. Result: reduced speed and power capability.

The second drawback has to do with low speed control. While the 1992 circuit does allow your drill or other appliance to run at quite low speeds, the result leaves much to be desired. There isn't much torque available and the speed regulation is poor. This means that if you're operating your drill at a low speed and you put a reasonable load on it, its speed will drop right away or it may stall completely.

Worse, the motor will tend to "cog". This is caused by erratic firing of the SCR (Triac) so that the motor gets intermittent bursts of power. An electric drill that is cogging badly is virtually useless and the only cure is to increase the speed setting which rather defeats the purpose if you want to operate at low speed.

The new SILICON CHIP Motor Speed Controller overcomes these drawbacks. The design does away with traditional phase control circuitry and uses switchmode power supply techniques to produce an outstanding controller for universal brush-type motors. By the way, before we go further we should point out that virtually all power tools and appliances use so-called universal motors. These are series wound motors with brushes. We'll have more to say on this point later in the article.

Why use a speed control anyway? Well, why not? Most power tools will do a better job if they have a speed control. For example, electric drills should be slowed down when using larger drill bits; they make a cleaner cut. Similarly, it is useful to be able to

Features

- Control from zero to maximum speed
- Good speed regulation under load
- Smooth low speed operation
- Freedom from cogging
- Can power appliances rated up to 2400W
- Overcurrent limiting
- Fuse protection
- Earthed diecast case
- Interference suppression included

What Motors Can Be Controlled?

We've noted elsewhere in this article that virtually all power tools and appliances use so-called universal motors. These are series wound motors with brushes. But how do you make sure that your power tool or appliance is a universal motor and not an induction motor. Induction motors must not be used with this speed controller.

In many power tools you can easily identify that the motor has brushes and a commutator – you see sparking from the brushes and that settles the matter. But if you can't see the brushes, you can also get a clue from the nameplate or the instruction booklet.

OK, so how do you identify an induction motor? Most induction motors used in domestic appliances will be 2-pole or 4-pole and always operate at a fixed speed which is typically 2850 rpm for a 2-pole or 1440 rpm for a 4-pole unit. The speed will on the name plate. Bench grinders typically use 2-pole induction motors.

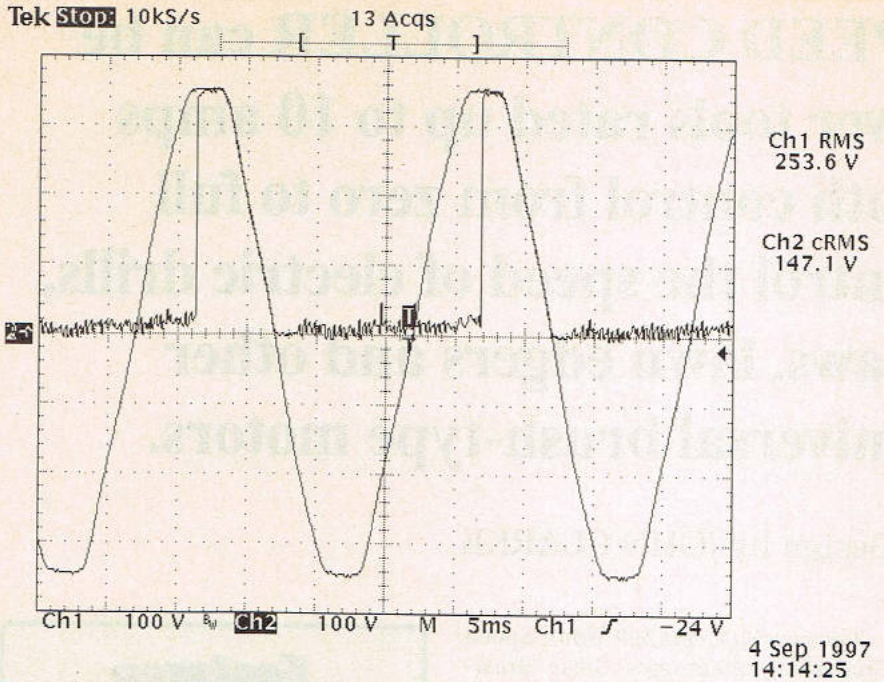


Fig.1: these waveforms illustrate the operation of a typical phase-controlled SCR when a motor is driven at a slow speed. The full sinewave is the 50Hz AC mains voltage, while the chopped waveform is the voltage applied to the motor. Its RMS value is 147V.

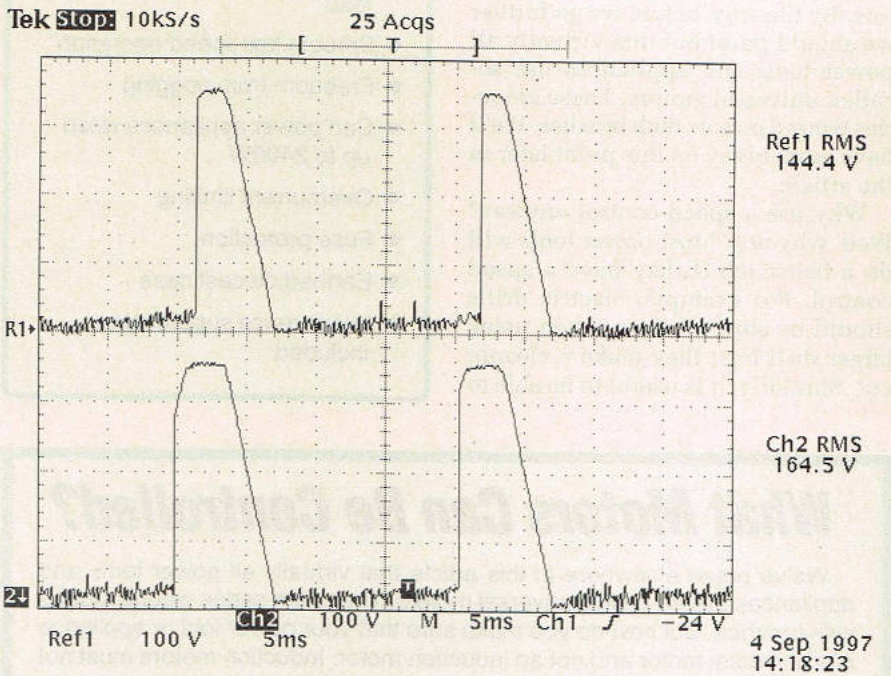


Fig.2: chopped waveforms from an SCR speed control at high and low settings. At the high setting (lower trace) the motor has 164V applied to it while at the low setting (upper trace) the motor has 144V applied. If the motor is to run at full speed, it would need to be fed with both the positive and negative half-cycles of the 50Hz mains waveform.

slow down routers, jigsaws and even circular saws when cutting some materials, particularly plastics.

The same applies to sanding and polishing tools and even electric whipper snippers are less likely to snap their lines when slowed down.

As mentioned above, the new design does not use phase controlled circuitry but uses switchmode principles. Having said that, we had better explain what we mean by phase control before we can illustrate the benefits of the new circuitry.

Phase control

Phase control refers to a method of triggering a Triac or SCR (silicon controlled rectifier) at various times during each half-cycle of the 240VAC mains waveform. If the Triac is triggered early in each half-cycle, the power applied to the load is high and if it is triggered late in each half-cycle, the power level is low. The term "phase control" comes about because the timing of the trigger pulses is varied with respect to the phase of the mains sinewave.

The oscilloscope waveform of Fig.1 shows the chopped waveform from a phase controlled SCR when a motor is driven at a slow speed. The full sinewave is the 50Hz AC mains voltage, while the chopped waveform is the voltage applied to the motor. Its RMS value is 147V.

Fig.2 shows the chopped waveform from an SCR speed control at high and low settings. At the high setting (lower trace) the motor has 164V applied to it while at the low setting (upper trace) the motor has 144V applied.

Note that these examples show only the positive half of the mains waveform being used, as is the normal case with a phase controlled SCR circuit.

If the motor is to run at full speed, it would need to be fed with both the positive and negative half-cycles of the 50Hz mains waveform. Normally this is not possible with an SCR circuit and while it is possible with a Triac, it is difficult to achieve without a complex circuit.

(We should note that full-wave control circuits are used in some washing machines using the Plessey TDA1085 power control IC. This uses tachometric feedback for a wide range of speeds from a series-wound motor.)

Another big problem with conventional phase controlled circuits is that the trigger pulse applied to the Triac or SCR is very short and if this corresponds with the time when the brushes hit an open-circuit portion of the commutator, no current will flow and consequently, the motor will miss out on a whole cycle of the mains waveform. This problem is more critical at low speed settings and is one of the rea-

sons for the "cogging" behaviour referred to earlier.

Speed regulation

In theory, most phase controlled SCR speed control circuits incorporate a form of feedback which is designed to maintain the speed of the motor under load. When the motor is loaded, the back EMF (electromotive force) produced by the motor drops and the circuit compensates by triggering the SCR earlier in the mains cycle. This helps to drive the motor at the original speed.

In practice though, the back-EMF generated by most series motors when the SCR is not conducting is low or nonexistent or it is produced too late after the end of each half-cycle to have a worthwhile effect on the circuit triggering in the next half-cycle. So while the theory says good motor speed regulation should be obtained, in practice, it doesn't happen in many cases.

Pulse width modulation

The new SILICON CHIP speed control circuit uses Pulse Width Modulation (PWM) and a different feedback method for speed regulation which solves the above problems associated with phase control.

Fig.3 and Fig.4 shows the voltage waveforms applied to the motor at high and low speed settings. What happens is that we rectify the mains voltage and then chop it up with a high voltage IGBT (Insulated Gate Bipolar Transistor) at a switching rate of about 1.2kHz. For the high speed setting the pulses applied to the motor are relatively wide (Fig.3) while at the low speed setting, the pulses are very narrow (Fig.4).

Note that there are 12 pulses during each and every mains half-cycle so that the motor does not miss out on large blocks of current because of erratic triggering. This means that the motor operates very smoothly over the whole of its speed range.

The speed regulation does not rely upon motor back-EMF. Instead it monitors the current through the motor and adjusts the pulse width to maintain the motor speed.

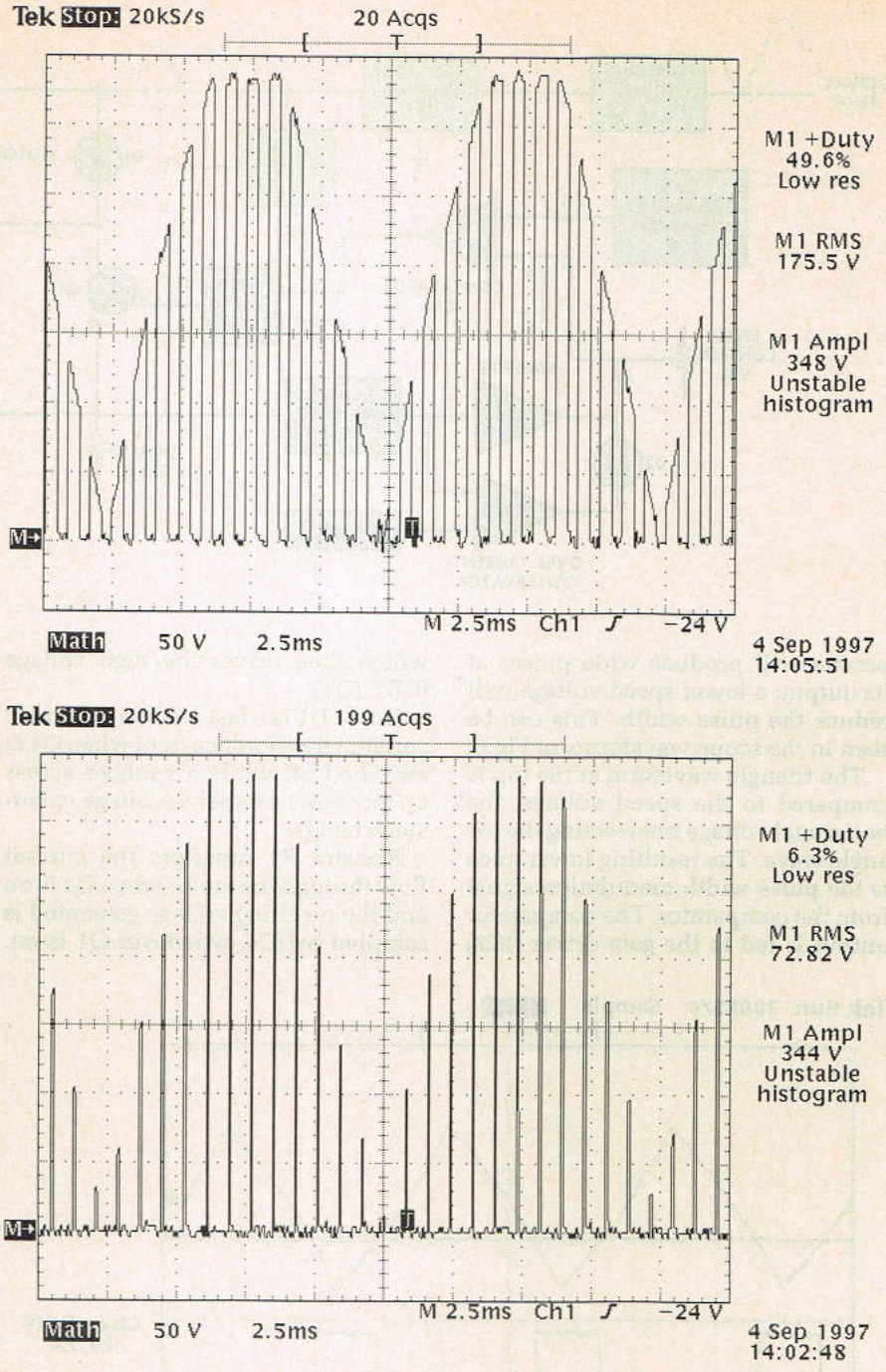


Fig.3 (top) and Fig.4 (above) show the voltage waveforms applied to the motor at high and low speed settings. The rectified mains voltage is chopped up with a high voltage IGBT (Insulated Gate Bipolar Transistor) at a switching rate of about 1.2kHz. For the high speed setting the pulses applied to the motor are relatively wide (Fig.3) while at the low speed setting, the pulses are very narrow (Fig.4). Note that there are 12 pulses during each and every mains half-cycle so that the motor does not miss out on large blocks of current because of erratic triggering. This means that the motor operates very smoothly over the whole of its speed range.

Block diagram

Fig.5 shows the basic circuit arrangement of the Motor Speed Controller. The 240VAC input waveform is fed through a filter and full wave rectified. The resulting positive-going waveform is fed to one side of the motor, while the other motor terminal is switched on and off via transistor Q1.

A triangle (ramp) waveform is generated using IC1b and this is applied to comparator IC1a where it is compared with the voltage level from VR1, the speed control potentiometer.

If the speed voltage is high relative to the triangle waveform, then the com-

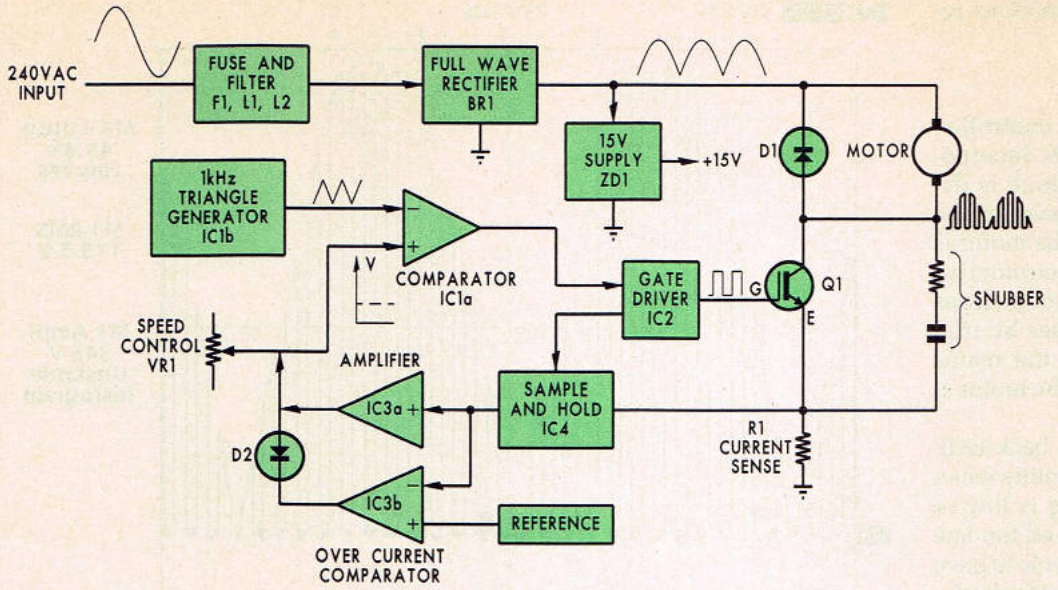


Fig.5: the basic circuit arrangement of the Motor Speed Controller. The 240VAC input is full-wave rectified and fed to one side of the motor, while the other motor terminal is switched on and off via IGBT Q1. Q1 is controlled by a conventional PWM circuit involving IC1, IC2 & IC3.

parator will produce wide pulses at its output; a lower speed voltage will reduce the pulse width. This can be seen in the scope waveforms of Fig.6.

The triangle waveform at the top is compared to the speed voltage, the horizontal voltage intersecting the triangle wave. The resulting lower trace is the pulse width modulation signal from the comparator. The comparator output is fed to the gate driver (IC2) which then drives the high voltage IGBT (Q1).

Diode D1 is a fast recovery diode to conduct the motor current when Q1 is switched off while a snubber across Q1 prevents excessive voltage excursions on Q1.

Resistor R1 monitors the current flow through the motor when Q1 is on and the resulting voltage generated is sampled by IC4, whenever Q1 is on.

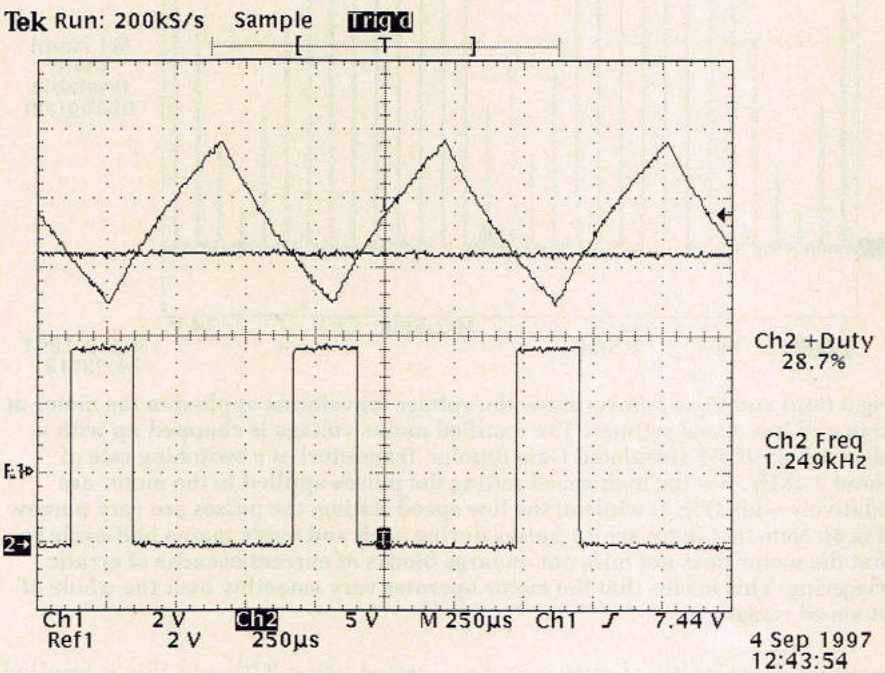


Fig.6: These waveforms show the interaction of the triangle waveform and the speed voltage. The triangle waveform at the top is compared to the speed voltage, the horizontal voltage intersecting the triangle wave. The resulting lower trace is the pulse width modulation signal from the comparator. The comparator output is fed to the gate driver IC2 which then drives the high voltage IGBT.

IC3a amplifies the voltage from R1 and applies it to the speed pot.

Thus an increase in motor current, as the motor slows down, leads to an increase in the output from IC3a to increase the speed setting from VR1 and this results in an increase in the voltage applied to the motor. Yes, this is a positive feedback system and too much positive feedback is not good so the amount of feedback is fairly critical to optimum circuit operation.

IC3b also monitors the voltage produced from R1 via IC4 and compares it against a reference voltage. If the voltage from R1 exceeds the reference threshold, IC3b's output goes low and reduces the speed pot voltage via diode D2. This reduces the voltage applied to the motor and provides current limiting.

Circuit description

The circuit for the Motor Speed Controller is shown in Fig.7. It comprises four ICs, several diodes, resistors and capacitors plus the high voltage IGBT, Q1.

IC1b is the triangle waveform generator and it is essentially an oscillator whereby the .018µF capacitor at pin 5 is charged and discharged via the 33kΩ resistor connected to the output at pin 12. The triangle or ramp waveform across the capacitor has an amplitude of about 5V peak-to-peak.

Comparator IC1a compares the triangle waveform at pin 10 with the speed voltage at pin 9, as set by VR1. VR1 is the centre portion of a voltage divider with a 1kΩ resistor connect-

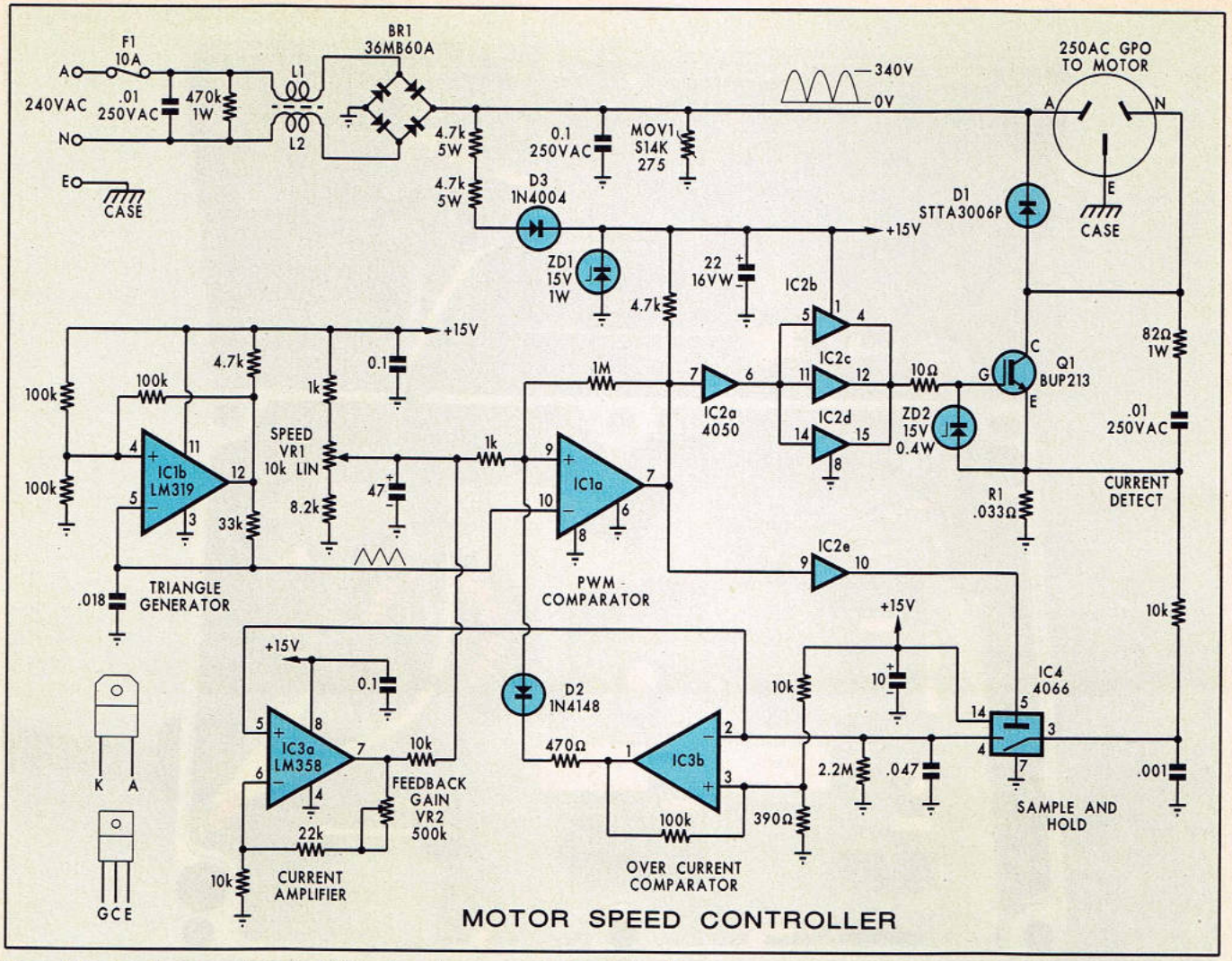


Fig.7: the circuit uses a 32A 1200V avalanche-protected IGBT (insulated gate bipolar transistor) as the switching element to the load. It is switched at 1.2kHz; ie, 12 times in each half-cycle of the 50Hz 240VAC mains supply.

ing to the +15V rail and an 8.2kΩ resistor to 0V. The speed voltage from VR1 is filtered with a 47µF capacitor to prevent any sudden changes in level and this voltage is monitored by the inverting input (pin 9) of IC1a via a 1kΩ resistor.

The 1MΩ resistor between pin 9 and the pin 7 output provides positive feedback to give a small amount of hysteresis in the comparator action. This is to prevent "hunting" in the comparator output when changing levels.

The pin 7 output of IC1a drives buffers IC2a and IC2e. IC2a drives three paralleled buffers, IC2b, 2c & 2d, which provide a high current capability to charge and discharge the gate of the high voltage IGBT Q1. The gate is protected from excessive drive voltage with ZD2, a 15V zener diode. Normally the circuit should have no way of providing excessive gate drive however we blew a number of devices during the development process when attempting to monitor gate drive levels with an oscilloscope. So the 15V zener has been included for insurance.

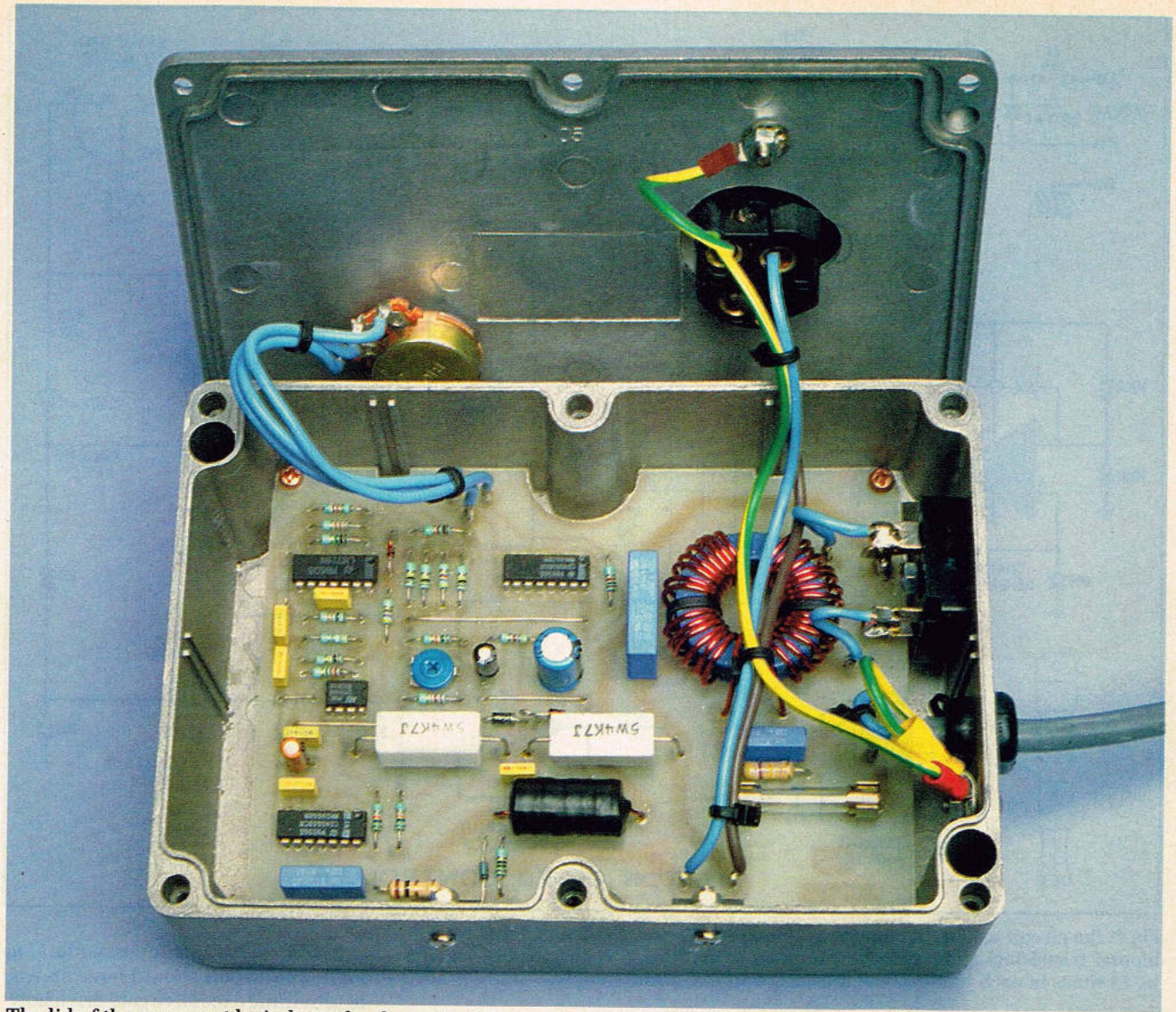
Three circuit features combine to ensure that the IGBT can safely switch high levels of current through the motor load. First, there is a snubber network comprising an 82Ω resistor and .01µF capacitor connected in series across the IGBT's source and drain and second, there is the fast recovery diode D1. Third, there is a 275VAC metal oxide varistor (MOV) connected across the output of the bridge rectifier. These measures combine to damp any spike voltages which would otherwise occur every time the IGBT switched off.

Finally, the specified IGBT is a Sie-

Warning!

(1) The entire circuit of this motor speed controller floats at 240VAC and is potentially lethal. Do not build it unless you know exactly what you are doing. DO NOT TOUCH ANY PART OF THE CIRCUIT WHILE IT IS PLUGGED INTO A MAINS OUTLET and do not operate the circuit outside its metal case.

(2) This circuit is not suitable for induction motors or shaded pole motors used in fans – see panel.



The lid of the case must be independently earthed by running an extra lead from a solder lug to the earth terminal on the mains socket – see Fig.8. Fit the earth solder lug mounting screws with washers and locknuts so that they cannot possibly come adrift.

mens BUP213 1200V 32A avalanche-protected device. We do not recommend substitution of lower rated devices. During the development of this project we ended up with quite a graveyard of IGBTs and Mosfets which should have been up to the task but were found wanting.

Current monitoring

R1 is a used to monitor the current flow through the motor and IGBT Q1. The voltage developed across R1 is fed through a low pass filter consisting of a 10kΩ resistor and .001µF capacitor to one side of a 4066 analog switch, IC4. This is the sample and hold circuit and IC4 is switched on to sample the voltage across R1 each time the IGBT is switched on. Hence, IC4's gate signal comes from comparator IC1a and is buffered by IC2e. The sampled signal from R1 is held in the .047µF capacitor at pin 4 of IC4.

The sampled voltage from IC4 is fed to two op amps, IC3a & IC3b. IC3a amplifies the voltage by about 53 when VR1 is set to maximum and 3.2 when set to minimum. IC3a acts to vary the DC level fed to comparator IC1a from VR1 and thereby compensates for speed variations in the motor.

IC3b acts as a comparator, comparing the sampled voltage from R1 with a reference voltage at its pin 3. If the current through R1 is excessive, the output of IC3b goes low and pulls pin 9 of IC1a low via diode D2 and a 470Ω resistor. This has the effect of greatly reducing the motor drive voltage.

Power for the circuit is derived directly from the 240VAC mains. Fuse F1 protects against shorts while the .01µF capacitor in conjunction with L1 & L2 prevents switching artefacts from the IGBT and motor being radiated by the mains wiring.

BR1 is a bridge rectifier with a 600V 35A rating. BR1 provides the circuit with the positive full-wave rectified mains voltage and this is lightly filtered using a 0.1µF 250VAC capacitor. Power for the low voltage circuitry is derived via two series 4.7kΩ 5W resistors, diode D3 and the 15V zener diode ZD1. A 22µF capacitor across the

Table 1: Capacitor Codes

Value	IEC Code	EIA Code
0.1µF	100n	104
.047µF	47n	473
.018µF	18n	183
.01µF	10n	103
.001µF	1n0	102

15V zener smooths the DC while diode D3 prevents the capacitor from discharging when the mains voltage falls to below 15V every half cycle. The result is a regulated 15V supply.

Construction

The Motor Speed Controller is constructed on a PC board which is coded 10311971 and measures 112 x 144mm. It is housed in a diecast case measuring 171 x 121 x 55mm. The PC board has circular cutouts to suit the case. By the way, we do not recommend a sheet metal case for this project. Since all the circuitry inside is at 240VAC mains potential, it is important that the case is strong and rigid.

The complete wiring diagram is shown in Fig.8. **THE EARTHING DETAILS OF THE CASE ARE MOST IMPORTANT SINCE THE IGBT, FAST RECOVERY DIODE D1 AND POTENTIOMETER VR1 ARE ALL AT MAINS POTENTIAL YET ARE ATTACHED TO THE CASE.** If the mica washers or the insulation of the potentiometer were to break down, the case would be live (ie, at 240VAC) if it was not properly earthed.

For this reason, the case lid must also be separately earthed, as shown in Fig.8 because otherwise the lid could be live if the potentiometer broke down and the lid was not actually attached to the case.

Begin construction by checking the PC board against the published pattern in Fig.11. There should not be any shorts or breaks between tracks. If there are, repair these as necessary. If the cutouts in the sides of the PC board have not been made, they should be done before any components are soldered on.

A large semicircular cutout is required on both the long sides of the board, as well as notches to clear the vertical slot channels in the sides of the case. Also you will need to round off the corners of the board. Make sure the PC board fits into the case before starting assembly.

You can start the board assembly by inserting the PC stakes and the links now and then the resistors, using the accompanying table for the colour codes. The two 5W resistors should be inserted so that they stand several millimetres above the PC board to allow cooling since each will be dissipating about 2.7W and will run hot.

When inserting diode D2 and the zeners, take care with their orientation and be sure to place each type in its correct place. Install the ICs, taking care to orient them as shown on Fig.8. D1 and Q1 are oriented with the metal flange towards the edge of the PC board and are located as high as possible with their leads extending about 1mm below the PC board.

The capacitors can be installed next. The accompanying capacitor table shows the various codes which may be used to indicate the capacitance values. The electrolytic capacitors must be oriented with the correct polarity.

L1 & L2 are wound on a single Neosid toroidal core as shown in Fig.9.

Parts List

1 PC board, code 10311971, 112 x 144mm
1 metal diecast case, 171 x 121 x 55mm
1 front panel label, 100 x 70mm
1 Neosid iron powdered core, 17-742-22 (L1,L2)
1 GPO mains power point (Clipsal NO.16N or equivalent)
1 10A mains cord and plug
1 cordgrip grommet
3 solder lugs
1 10kΩ linear potentiometer (VR1)
1 500kΩ horizontal trimpot (VR2)
1 knob
2 3AG (or 2AG) PC mount fuse clips
1 10A 3AG fast blow fuse (or 2AG), (F1)
2 3mm x 10mm screws, nuts & star washers
4 4mm x 15mm screws, nuts and star washers plus two locknuts
7 small cable ties
1 TO-218 insulating washer
1 TO-220 insulating washer
2 insulating bushes
1 500mm length of blue 10A mains wire
1 150mm length of brown 10A mains wire
1 1.5m length of 1mm enamelled copper wire
1 1m length of 0.8mm enamelled copper wire
1 140mm length of 0.8mm tinned copper wire
1 26mm length of 15mm ID heatshrink tubing
9 PC stakes

Semiconductors
1 LM319 dual comparator (IC1)
1 4050 hex CMOS buffers (IC2)
1 LM358 dual op amp (IC3)
1 4066 quad CMOS analog switch (IC4)
1 Siemens BUP213 32A 1200V IGBT (Q1)
1 STTA3006P SOD93 30A 600V fast recovery diode (D1)
1 1N914, 1N4148 signal diode (D2)
1 1N4004 1A 400V diode (D3)
1 15V 1W zener diodes (ZD1)
1 15V 400mW zener diode (ZD2)
1 36MB60A 35A 600V bridge rectifier (BR1)
1 S14K275 275VAC metal oxide varistor (MOV)

Capacitors
1 47µF 16VW PC electrolytic
1 22µF 16VW PC electrolytic
1 10µF 16VW PC electrolytic
2 0.1µF 63V MKT polyester
1 0.1µF 250VAC X2 class MKT polyester
1 .047µF 63V MKT polyester
1 .018µF 63V MKT polyester
2 .01µF 250VAC X2 class MKT polyester
1 .001µF 63V MKT polyester

Resistors (0.25W, 1%)

1 2.2MΩ	2 4.7kΩ
1 1MΩ	2 4.7kΩ 5W
1 470kΩ 1W	2 1kΩ
4 100kΩ	1 470Ω
1 33kΩ	1 390Ω
1 22kΩ	1 82Ω 1W
4 10kΩ	1 10Ω
1 8.2kΩ	

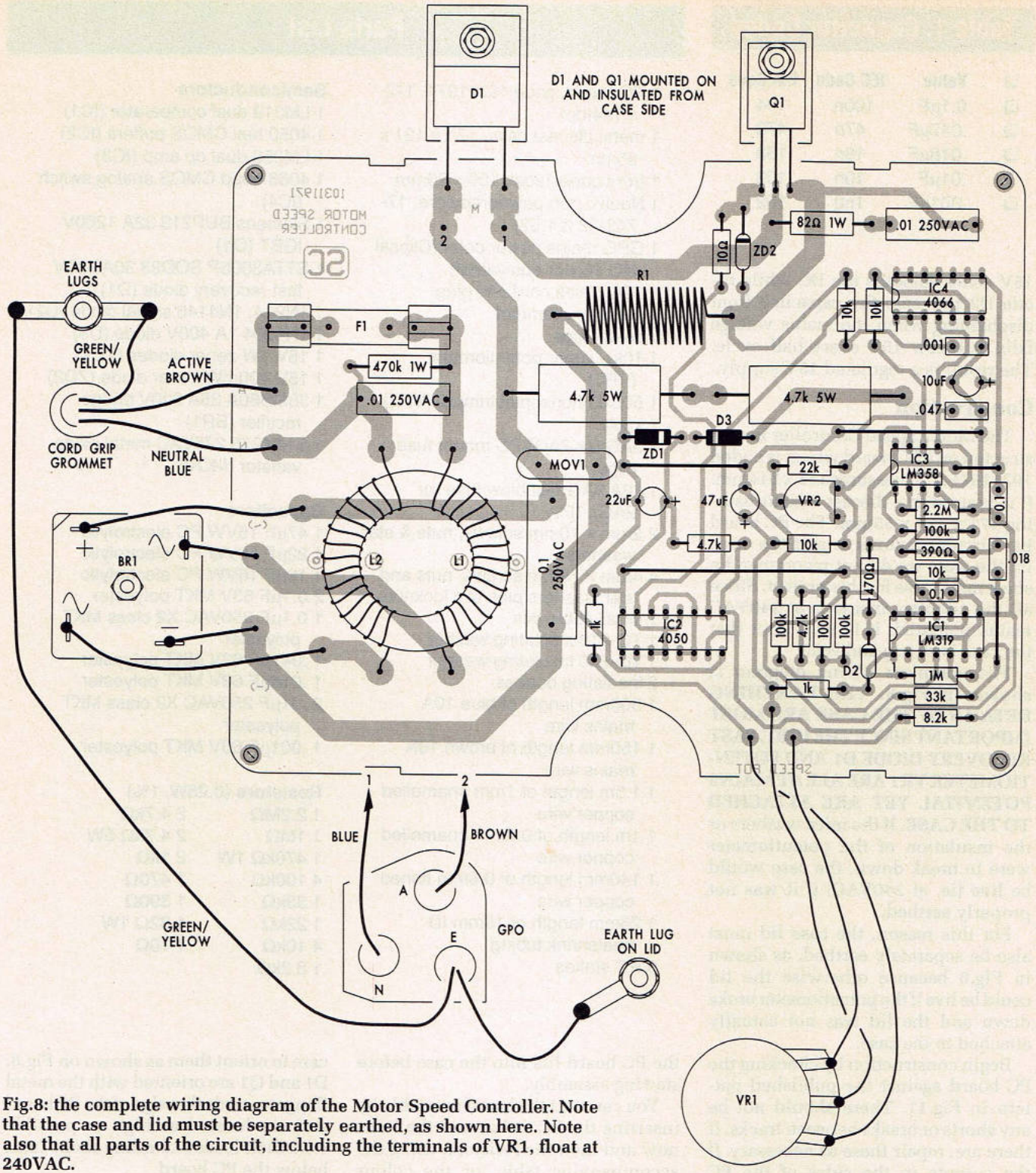
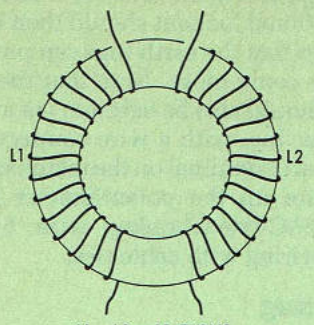


Fig.8: the complete wiring diagram of the Motor Speed Controller. Note that the case and lid must be separately earthed, as shown here. Note also that all parts of the circuit, including the terminals of VR1, float at 240VAC.

Make sure that there are an equal number of turns on each winding and that they are wound in the directions as shown. Insert the wire ends into the PC board holes and secure the toroid with two cable ties. The wire ends can be soldered to the PC board using a hot soldering iron to strip the self-fluxing insulation on the wire.

The current monitoring resistor is made from a 1m length of 0.8mm enamelled copper wire which is wound onto a 10mm former (3/8"). This may be a drill bit, pen or a wooden dowel. Wind on about 26 turns then remove the former and secure the coil with insulation tape so that each winding touches the adjacent one. Bend the wire ends outward and place a 26mm length of heatshrink tubing over the coil and shrink it down with a hot air gun. Re-bend the wire ends and secure in place into the PC board mounting holes.



L1 : L2 : 15 TURNS
1mm ENAMELLED COPPER WIRE
ON NEOSID 17-742-22
IRON POWDER TOROID

Fig.9: winding details for the input filter choke. Note that L1 and L2 are wound so that their flux cancels in the toroid core.

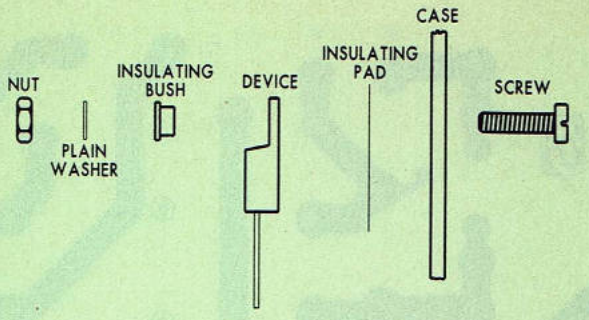


Fig.10: mounting details for the IGBT (Q1) and the fast recovery diode (D1).

The bridge rectifier (BR1) is attached to the PC board with the (-) and adjacent AC terminal sitting over and soldered to PC stakes. The other AC terminal and the positive (+) terminal are wired to the PC board pins using 10A 250VAC-rated hookup wire.

Fuse F1 is mounted in fuse clips which attach to the PC board as shown. We have catered for both 2AG and 3AG sizes. Clip the fuse into the clips first, insert them into the PC board and solder in position.

Mounting the hardware

Insert the PC board into the case and mark the mounting hole positions for diode D1, IGBT Q1 and bridge rectifier BR1. Note that the leads for D1 and Q1 must be bent so that the metal flange of each device is in contact with the case sides. Remove the PC board and drill out these holes plus holes for the cordgrip grommet and the earth lug screw. The holes for D1 and Q1 must be deburred with a larger drill to prevent punch-through of the insulating washers.

Attach the PC board to the case with the supplied screws (yes, they do come with the case) and secure D1 and Q1 to the case with a screw, nut, insulating washer and insulating bush. The arrangement for this is shown in Fig.10. If you use a mica washer apply a smear of heatsink compound to the mating surfaces before assembly. Silicone heatsink washers do not require heatsink compound.

After mounting, check that the metal tabs of the devices are indeed isolated from the case by measuring the resistance with a multimeter.

The bridge rectifier (BR1) is secured to the case with a 4mm screw, nut and star washer. It does not require an insulating washer between its body and the case.

Mark out and drill the case lid for the mains socket and potentiometer. Attach the mains socket with the 4mm screws and nuts and secure the pot after the stick-on front panel label has been affixed.

Solder the Active and Neutral wires of the power cord to the stakes on the PC board and secure the cord with a cordgrip grommet. The earth connection on the mains socket should be run to a solder lug using green/yellow mains wire.

Similarly, solder the earth wire from the mains cord to a solder lug and connect both solder lugs to the case

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	2.2MΩ	red red green brown	red red black yellow brown
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	4	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	4	10kΩ	black red orange brown	black black red brown
❑	1	8.2kΩ	grey red red brown	grey red black brown brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	390Ω	orange white brown brown	orange white black black brown
❑	1	82Ω	grey red black black	n/a
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	1	1Ω	brown black gold gold	brown black black silver brown

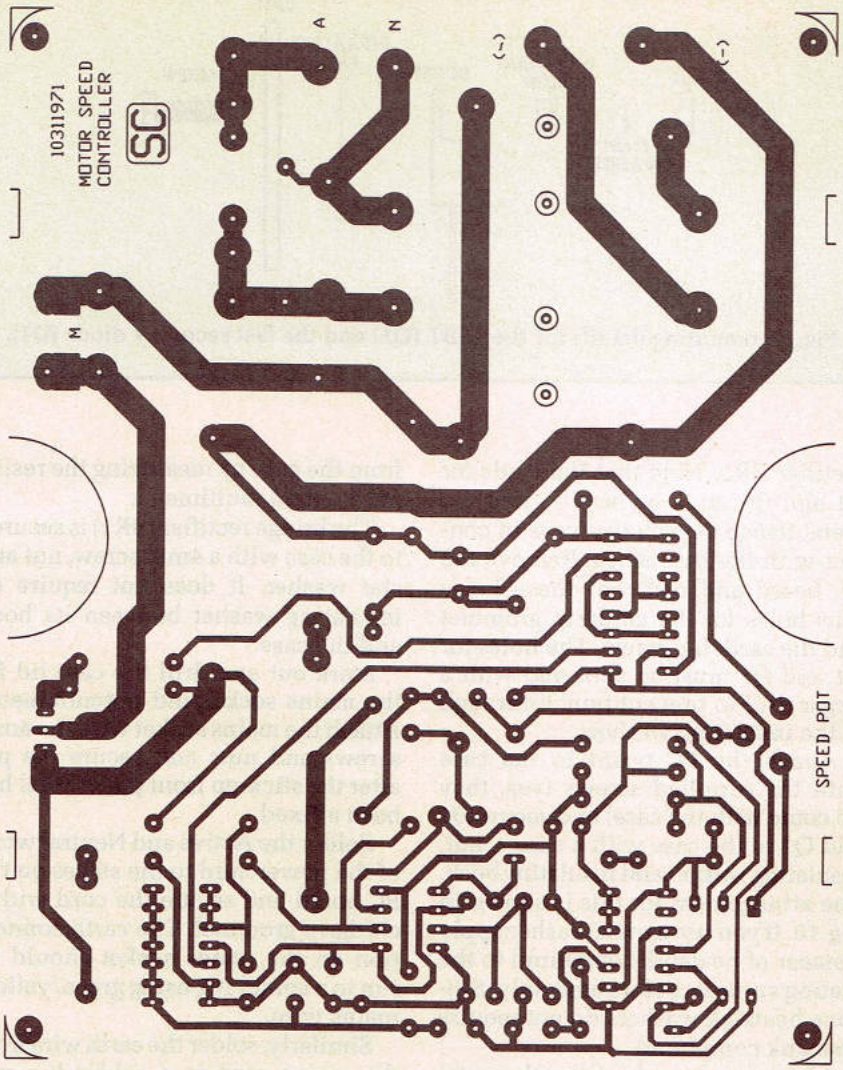


Fig.11: check your PC board by comparing it with this full-size etching pattern before installing any of the parts.

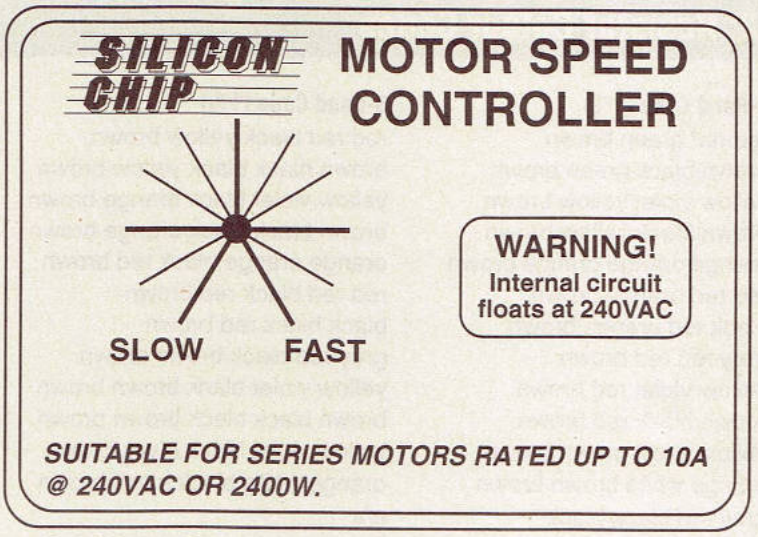


Fig.12: this full-size front panel artwork can be used as a drilling template for the front-panel speed control.

using a screw, nut and star washer. An additional locknut should then be fitted so that the earth lugs can not possibly come loose. Note that the case lid should also be earthed, via a third solder lug, with a wire connected to the earth terminal on the mains socket.

Wire up the potentiometer using 250VAC-rated hookup wire. Secure the wiring with cable ties.

Testing

Before you power up the circuit, set trimpot VR2 to the mid-position – this setting should give good performance with most motors. This done, check all of your wiring very carefully against the circuit of Fig.7 and the wiring diagram of Fig.8. Use your multimeter to check that there is no leakage between the Active and Neutral wires of the power cord and the case. Also check that the case and lid are connected to the earth pin of the power cord. The lid should be screwed to the case.

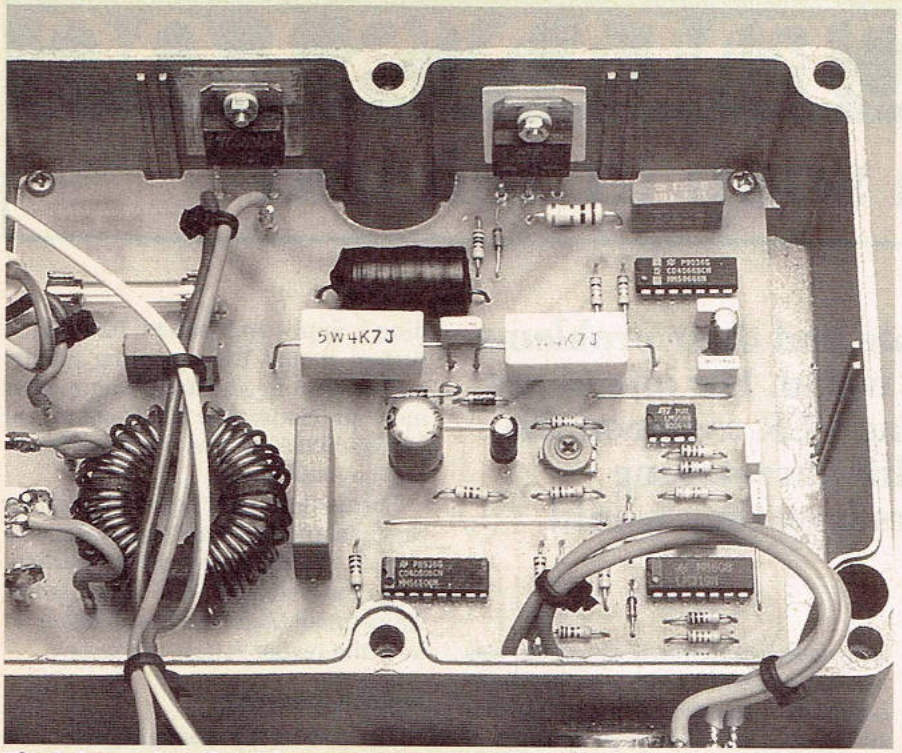
The safest and best way to test the circuit operation is to connect a load. This may be an ordinary incandescent lamp with a rating of between (say) 40W and 100W. Apply power and check that you can vary the brightness of the lamp from zero up to full brilliance. If that checks out OK, connect up a drill or other power tool and check that you can vary its speed over the full range. If so, your project is complete but some motors may require adjustment of VR2 for best speed regulation.

In practice, if VR2 is adjusted too far anticlockwise, the motor will tend to be overcompensated when loaded and will actually speed up. It may even hunt back and forth between a fast and slow speed. Back off the adjustment for VR2 for best results. This must be done on a trial and error basis, with the plug removed from the mains outlet before each adjustment. Replace the lid before reapplying power. If you are using a drill for example, at fairly low speed, the motor should not slow down by much as you put a reasonable load on it.

Troubleshooting

If the speed controller did not work when you applied power, it's time to don your troubleshooting hat.

Note that all of the circuit is connected to the 240VAC mains supply and is potentially lethal. This includes



The holes in the side of the case for D1 and Q1 must be deburred using an oversize drill to prevent punch-through of the insulating washers. After the devices have been mounted, use your multimeter (set to a low ohms range) to confirm that their metal tabs are indeed correctly isolated from the case.

the tabs of D1 and Q1, the terminals of potentiometer VR1 and all other parts. Do not touch any part of the circuit when it is plugged into a mains outlet. Always remove the plug from the mains outlet before touching any part of the circuit.

If you wish to work on or measure voltages in any part of the circuit, you really should connect it via an isolating transformer. Failing that, you can at least check that there is approximately 15V present in the circuit by connecting a multimeter across the zener diode ZD1.

If you wish to check the circuit operation in detail, you should power it from a low voltage power supply set to provide 14V. If you provide 15V, you run the risk of blowing zener diode ZD1. Note that the unit must not be plugged into 240VAC if the low voltage part of the circuit is to be separately powered.

Assuming that you are powering the unit from a 14V power supply, you can use your multimeter to check that +14V is present at pin 11 of IC1, pin 1 of IC2, pin 8 of IC3 and pin 14 of IC4. You can also check the circuit operation by measuring the average DC levels around the circuit. For example, if the circuit is working correctly, you should be able to vary the voltage at pin 7 of IC1a by winding the speed pot up and down. The same effect should be observed at the gate of the IGBT.

If you have an oscilloscope you should be able to observe the waveforms shown in Fig.6.

Should you wish to monitor any of the other waveforms illustrated in this article, the circuit will need to be powered from 240VAC again and will then be completely live. If you do connect an oscilloscope under these conditions, you cannot connect the earth terminal of the probe to any part of the circuit.

In fact, the only really safe way to monitor waveforms in the circuit when it is powered is to use an oscilloscope with fully floating differential inputs.

One final point: if you are using this controller with a high power tool such as a large circular saw or 2HP router, it will not give the same kick when starting. Because of the current limiting, the motor will take a few seconds to come up to full speed. Normally though, if you want to use the appliance at full speed, it is better not use the Speed Controller at all. **SC**

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SERVICEMAN'S LOG

From soap to Teletext

It takes all sorts of people and their problems to make a serviceman's world. For one of my customers, a misbehaving VCR assumed the proportions of a major life threatening emergency. One wonders how they would react to the real thing.

Mrs Proby likes – no, that word is too soft – loves, even adores, her soaps (situation comedies for the uninitiated). She lives for them; is addicted to them. In between watching and recording them, she somehow makes time for her family. But, inevitably, disaster struck; the video recorder wouldn't work. It was a real emergency and it had to be fixed immediately.

The recorder was a Sony SLV-X50AS and, on examination, the problem was worse than she could possibly have imagined – the recorder had had the audacity to actually chew up some of her beloved tapes and they were ruined! I did my best to calm her and tried to sound sincere as I pointed out that worse things can happen in life. But she was inconsolable. Eventually, I managed to convince her that I would do my best to fix it as soon as possible.

Afraid of what might happen if I didn't apply immediate first aid, I rushed it into the operating theatre and opened it. She had given me her most precious tape to examine but unfortunately it was in a real mess and beyond repair.

Fortunately, I did have a manual for the machine and I have reproduced a couple of diagrams from it, particularly the section "VHS Mechanical Adjustment Manual II", which should help the reader follow the story.

Seized bearing

The reason for the damage became obvious when a dummy tape was run. The RVS guide (No.8) – the reverse search arm – had almost seized on its bearing and wouldn't free the tape to retract into its housing on eject. I hoped I could free this without removing it, as this would save time because it would not then require realignment.

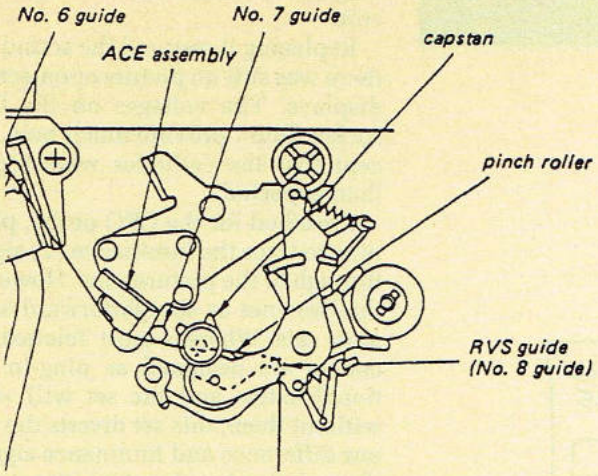

Fig.1: portion of the deck around the capstan/pinch roller area in the Sony SLV-X50AS VCR. The RSV guide is partially obscured and shown dotted.

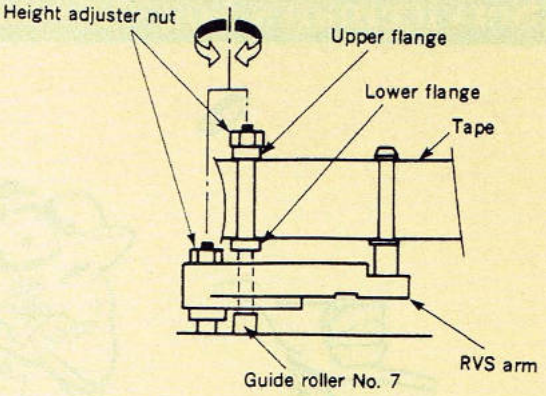

Fig.2: side view of the RVS (reverse search) arm, showing its relationship to guide roller No.7 in the Sony SLV-X50AS. Note the adjuster nuts.

And I was in luck – after a squirt of CRC and some wiggling, the arm moved freely.

After cleaning up any excess CRC with alcohol, the tape went in and out perfectly. I cleaned the heads and tape path and initially thought that that was the end of it; that I had scored an easy one. But I was wrong. On tape play there was considerable curl on the lower edge of the tape, just after the pinch roller, and the tape was being mutilated as it went into the cassette.

I removed the pinch roller, cleaned and roughened the rubber, and tried again. It was still no good so I fitted a new pinch roller assembly. This improved the situation enormously but the tape was still curling a little on the RVS guide. There was nothing for it – I would have to remove, clean and realign this guide according to the instructions on page 25 of the manual.

The gist of this adjustment is the need to move both the RVS guide (No.8) and guide No.7 up or down until the tape tracks with both guides and with the nearby ACE head assembly. This adjustment is by means of height adjuster nuts, one for each guide.

The No.7 guide appeared to be correct, so I concentrated on the RVS guide. Unfortunately, the only adjustment setting which brought the alignment close to correct was to have the nut screwed hard down. This not only failed to cure the problem but it meant that, on eject, the arm jammed on a gear just below it.

There was only one thing for it. I had to replace the arm – but where could I get one in a hurry? This part does not usually need to be replaced. After ringing around, I found a colleague who had one and would let me have it in view of the emergency. I dashed into the ambulance and shot around to pick up the donor organ.

Secondhand shop

My colleague, Jim, is the senior technician at a busy secondhand shop. He spends his days growing white hair from refurbishing TV sets and video recorders, which they purchase from all and sundry. He was in a talkative mood when I arrived and was muttering rude words about two cranky TV sets which had defied all his efforts to repair them. It had got to the stage where he was fed up and was planning to send them off to auction.

A cursory glance showed them to be low-cost generic TV sets made in China but both were modern and looked good. I stupidly volunteered to have a look at them if he would care to stick them in the back of the "ambulance". I then shot back to the operating theatre and transplanted the new part into the Sony vide recorder.

This time, realigning the arm produced the desired effect, the tape now running through the guides perfectly. I carefully examined the old arm and pinch roller but could not detect any imperfections. The arm, which is a chrome-plated steel rod embedded in a diecast aluminium block, didn't look the slightest degree bent or distorted. However, it only needs a minute change to cause problems like these.

Anyway, I pronounced that the patient would live and so undoubtedly would Mrs Proby. But I did issue her with a prescription of sorts, advising her to purchase some new tapes and ditch the old ones (if she can bring

herself to do it). Anyway, she thanked me most profusely; I thought she was going to call me Doctor but she didn't.

Jim's TV sets

When things were quieter, I decided to have a go at Jim's TV sets. The first was a 51cm Palsonic 5138 with remote control, twin speakers, and Fast Text – the Palsonic version of Teletext. The fault ticket read, "No picture, no sound".

Jim thought that the fault lay in the Teletext section but he didn't have a circuit diagram. So my first step was to order a manual from N & G Enterprises. The second set was an Aiko Supervision VST 60, model 2801, as sold by Cumberland TV. This was also dead and so I ordered a manual for this as well.

A week later I received photocopied circuits for both models. The Palsonic circuit looked very similar to a Chinese chassis used in Teac and some other sets.

At switch on, the LED on the front panel lit up and a telltale 15,625kHz whistle suggested that the line output stage was working. The remote control had no effect but turning up the screen control (G2) gave a full-screen faint blank raster.

With no sound or picture, I started by measuring the various voltage rails. Most are not marked on the circuit but in any case, they seemed a little high. Shrunk heatshrink on an electrolytic capacitor in the power supply (C514, 47µF/50V) pointed to the likely culprit and I immediate replaced it to prevent further damage.

I was now getting 130V, 20V, 16V and 8V on the various rails which seemed reasonable but there was no 16V on pin 3 of connector XT01 on the main board, which mates with XT01 on the Teletext board. This feeds NT01, a 12V IC regulator on the Teletext board.

Following the 16V rail back from pin 1 of XT101 on the main board, I ran into a 10Ω 1W resistor (R536) which is not marked on the circuit diagram. This resistor was open circuit.

Replacing it restored the sound but there was still no picture or on-screen displays. The voltages on the CRT socket didn't provide much help, except that the cathodes were higher than expected.

I reached for the CRO probe, planning to trace the luminance (Y) signal through to the picture tube. However, this was not as straightforward as in most sets. Whereas most Teletext decoders are designed as plug-in optional extras and the set will work without them, this set diverts the colour difference and luminance signals through the decoder. Also, the circuit is somewhat misleading as to what plug fits into what socket.

I was able to trace the Y signal into the Teletext card at connector XT03 (pin 1) but nothing seemed to be coming out on XT02; or rather, on a Y pin adjacent to XT02. From there, the path goes to X401 on the CRT board.

This confirmed that the decoder could not be bypassed and so would have to be fixed. However, I didn't fancy rushing in and replacing suspect ICs, particularly as they cost, on average, about $30 each.

It was time for some help. I phoned N & G Enterprises and was informed that the decoder gave very few problems – the only thing they were aware of was the 27MHz crystal. I checked this and could find nothing wrong but I removed a lot of black gunk that had been coated over its pins.

A red herring

By now, this line of attack was looking like a red herring. I went back to the CRT socket and followed up on my earlier observation that the tube cathode voltages appeared to be high. It didn't take long to discover that there was no voltage on the bases of video drive transistors V402, V405 and V409, although voltage was present on their emitters. The base bias is supplied via R403, a 120kΩ resistor connected to the 180V rail, and this resistor was very high. Replacing it restored the picture completely.

So problem solved but one part of this investigation has me puzzled. When checking with the CRO, I could swear I saw luminance and colour difference signals going into the Teletext board but nothing coming out to the CRT board. But now there were

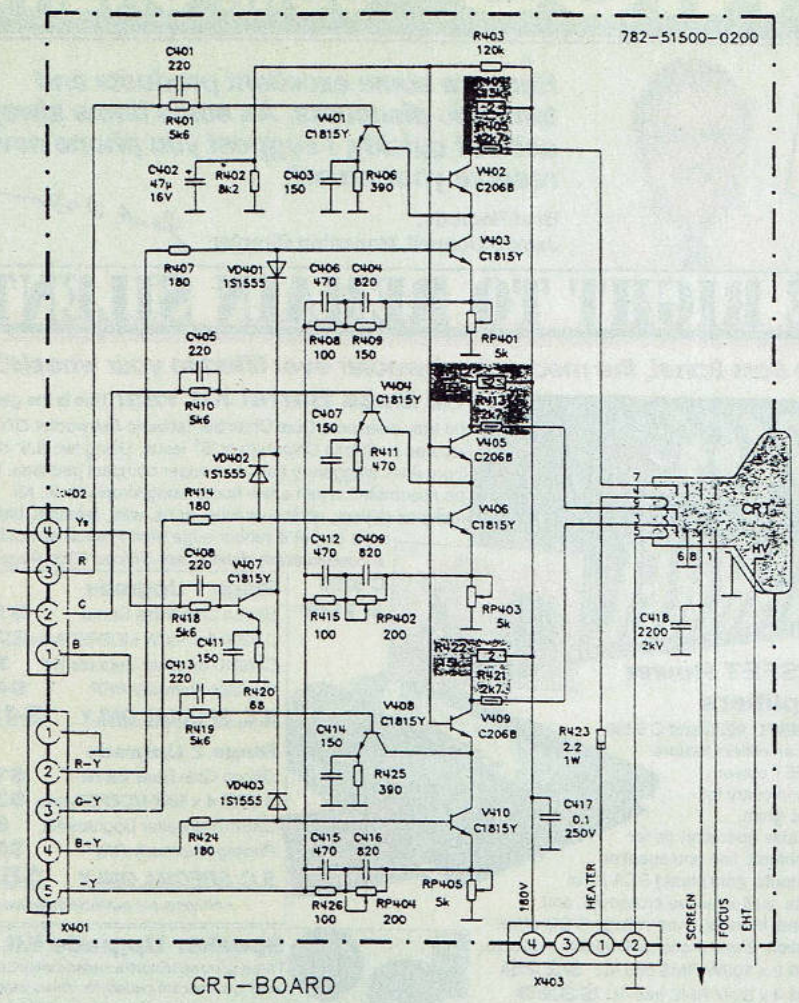

Fig.3: the CRT board in the Palsonic 5138, showing the three video driver transistors, V402, V405 and V409.

signals coming out of the board after I had replaced R403. I can see no correlation between the failure of R403 and the lack of signal into X401 from the decoder. I even removed R403 and rechecked with the CRO and there was still plenty of signal.

And by what process had I concluded that it was the Teletext card that was faulty? Well, in hindsight, I cannot explain it. Jim had voiced the thought that it might be in the Teletext section, so perhaps I had allowed this to lead me astray.

The remote control needed a new rubber keypad and after alignment, the picture was good and all "Fast Text" functions checked out OK.

Destructive overload

Jim's second set filled me with dread when I found that the power supply had suffered a severe destructive overload and a wide range of parts had been affected. Some parts, apparently damaged, had been replaced, some had been partially disconnected, and some were missing altogether.

I refitted the disconnected parts and replaced all the missing ones. Then I disconnected it from the main chassis, substituted a 100W globe as a load on the 136V rail, and removed fuse FU502 in this line. I applied 240V AC power via a 200W globe and a Variac, connected meters everywhere and switched on. The 200W globe lit to full brilliance immediately, indicating a short circuit.

Switching transistor V501 and diode VD504 in the bridge were both short circuit and were replaced. When I switched it on again, the power supply started to squeal as I turned the Variac up to around 100V and was obviously under stress. There was no output.

I examined the circuit very closely. All the small electrolytics had been replaced and so had R509, a 56kΩ resistor coming off the positive rail from the bridge. All the high value resistors measured OK. The small transistors had all been replaced with substitutes but even the discovery that transistor V503, part of a Darlington pair, was fitted the wrong way around didn't solve the problem.

With the CRO connected, the waveform on the collector of V501 consisted of a series of positive spikes, suggesting that the mark space ratio was indicating a heavy load. I didn't twig to the significance of this immediately and put it down to the low input (100V) to which I had set the Variac.

To cut a long story short, I replaced V504, C519, C521, V505, VD513 and many more parts around this area before the penny dropped. There was no ringing in the waveform indicating, on the one hand, that there were no shorted turns in the chopper transformer (T503) but that there was a short circuit somewhere across the secondary.

All the diodes measured OK out of circuit but there was something wrong around diode VD518 and it didn't take long to find that C525, a 470µF 200V electrolytic across pins 19 & 21 of T503, was short circuit. Replacing this and turning up the Variac restored everything. Now for the acid test – I reconnected the main chassis to the power supply, replaced fuse FU502 and switched on.

Unfortunately, it still wouldn't work. A quick check soon showed that there was 136V on the collector of V303, the horizontal output transistor, but nothing on the collector of V302 which drives it. The reason for this wasn't hard to find – the primary winding of transformer T301, which couples these together, was open, probably due to corrosion from the black gunk all around it.

Ordering and fitting a replacement transformer fixed the final problem and the set burst into life at last. Jim was pleasantly surprised and I think only he fully appreciated the time I spent going up so many blind alleys before tracking down the various faults. **SC**

ALTRONICS COMPONENTS

ALTRONICS Fax Order Line: (08) 9328

FANTASTIC BARGAINS FROM ALTRONICS

Here are some excellent products and fantastic discounts. As some items always sell out quickly, I suggest you phone now to reserve your order!

Best Regards,
Jack O'Donnell, Managing Director

Jack O'Donnell

YOU HAVE THE RIGHT TO REMAIN SILENT!

...You also have the right to the Bass Barrel, the meanest subwoofer ever fitted to your wheels!!

Installing the Silicon Chip Bass Barrel and adding one our exciting MOSFET power amps will dramatically enhance your car audio system.

Here's how...

Stage 1 Upgrade: The speaker wires from your standard radio/cassette (head unit) are connected to the input of the 2 x 100W RMS amplifier. This amp can be bridge connected to provide a low-pass 100W RMS mono channel to power the Bass Barrel subwoofer in the rear of the car. For even further improvement, connecting the **Speaker Upgrade Kit** to your front system will add incredibly crisp and clear top end to your system and provide superb stereo imaging.

Stage 2 Upgrade: The head unit is connected to the 4 x 50W RMS amplifier. This amp can be bridged into 3 channel mode (instructions included) to provide a low-pass 100W RMS mono channel to power the Bass Barrel subwoofer. The remaining 2 x 50W RMS stereo channels are connected to your existing front (or rear) speakers. The result is a powerful, punchy car audio system with bass you can feel as well as hear. Connecting the **Speaker Upgrade Kit** to the front system will add crisp top end to your system and improve the stereo imaging.

The Bass Barrel Kit *YES!*

This is the genuine and truly awesome Dual Chamber Isobaric Subwoofer DIY kit featured in *Silicon Chip* August '97 issue. Using two 6.5" drivers, it provides staggering bass in a super compact package. It can be assembled in just a few hours using simple tools. Kit includes drivers, enclosure tube, ports, wire, terminal, baffles, even carpet & rubber edge trim! ***For full specifications & construction details, see Silicon Chip August '97.***

C 3220 $199

MOSFET Power Amplifiers

The ***NEW*** C 9220 and C 9230 power amplifiers feature MOSFET power supply circuitry for serious grunt, bridgeable operation (ie for subwoofers), line and speaker level inputs, gold plated RCA input sockets, built-in active crossover, and overload, thermal, over-voltage & DC offset protection. 2 and 4-channel models available.

C 9220 2 x 100W RMS into 4Ω **$229**
C 9230 4 x 50W RMS into 4Ω **$329**

Features active crossover & bridgeable operation!

Stage 1 Upgrade	
Silicon Chip Bass Barrel	$199
C 9220 2 x 100W MOSFET Amp	$229
CX6210 Speaker Upgrade Kit	$45
Package Normally RRP	$473
S.C. SPECIAL ONLY	**$450**

Stage 2 Upgrade	
Silicon Chip Bass Barrel	$199
C 9230 4 x 50W MOSFET Amp	$329
CX6210 Speaker Upgrade Kit	$45
Package Normally RRP	$573
S.C. SPECIAL ONLY	**$550**

• *All items are available individually*

Speaker Upgrade Kit

These genuine Motorola surface mount piezo super tweeters are perfect for stereo imaging enhancement and provide crisp top end for your car audio system. Kit includes tweeters, crossover capacitors, speaker wire and installation instructions.

CX6210 $45

Credit card holders, phone our Toll Free Order Line and we can despatch your order to you ***SAME DAY!*** **1-800 999 007**

Note: All orders are plus delivery and handling $12

IRODA 120W Butane Soldering Iron

AT LAST! A BIG GAS IRON! This butane powered iron has a HUGE 120W heating capacity. Features a "one-touch" internal piezo ignition for super-easy starting, and a thumb-wheel heat control. It can be started and adjusted to the correct heat using one hand, and it's so well balanced it can be used for even the most delicate soldering jobs! The massive gas storage chamber can provide up to 4 hours operation, and is refilled using a standard butane refill canister. A MUST for installers, mobile technicians, on-site service personnel, auto-electricians etc.

"This has all the convenience features of a normal butane iron, such as quick heating, no power cords, light weight and best of all, it comes with a blow torch tip."
Silicon Chip Magazine, Sept '97

T 2600 Normally $129, NOW Just **$99** ea

FREE BONUS! **The first 100 callers to purchase a T 2600 receiver a T 2447 Gas Refill and a T 1100A Roll of solder, together valued at $7.95 *FREE!***

Solder Roll BARGAIN!

OOPS! This solder is a 40/60 mix of tin/lead, instead of the regular 60/40. We've tested it, and it solders just fine! Stock up at fantastic rates and keep some handy in the workshop! ***Available in 0.8mm or 1mmØ sizes.***

T 1100A 0.8mm Was $6.50 a Roll, NOW **$3** ea,
T 1110A 1mm Was $6.25 a Roll, NOW **$3** ea,
or Buy 5 Rolls for **$12** (mixed sizes OK!)

What a Super Deal! Stock up on solder at a bargain price!

12" Bass Driver

Just the shot for adding some wallop to your hi-fi, car audio, or home theatre system. This 300mm 8Ω sub driver features a super-rigid Poly Emulsion Coated Cone (PECC), with a high-efficiency foam surround has low-Q, low resonance and high efficiency.

Pmax: 100W RMS, **Fo:** 25Hz
Sensitivity (1W/1m): 92dB
Qts: 0.342, **Vas:** 207.8L
C 3100 Normally $99,
NOW JUST **$65**

YOU WANT BASS? Try this 12" beast for size!

Vented enclosure details supplied FREE on request!

24VDC to 13.8VDC Converter

Converts 24V DC to 13.8V DC at up to **5 Amps** for use with stereos, CB & Two-Way radios, or equipment designed to operate in a vehicle. Suitable for vehicles such as trucks, tractors, and some 4WDs which are fitted with a 24V battery system. Features overload protection and fused output with a rugged extruded aluminium case.

M 8160 Normally $55, NOW **$45**

Use 12V equipment in trucks or tractors with 24V battery systems!

Micron Series III Soldering Station

Amazing Special! A Professional Soldering Station for Under $100!

The *MICRON* Series 3 soldering station employs electronic switch mode circuitry in lieu of a mains transformer. Excellent for all general purpose and production soldering. **Features:** • High insulation ceramic heating element • Rapid heat-up and heat recovery • Heater insulation of over 100MΩ • Zero voltage circuit minimises high voltage spikes & magnetic fields to prevent damage to sensitive devices • Continuous temperature adjustable from 250° to 430°C • Grounded power cord • Selecting the desired operating temperature is as simple as turning a knob. *Supplied with Long-Lasting Iron Clad Tip!*

T 2443 Normally $129, NOW **$99**

1-800 999 007 PERTH (08) 9328 1599

Doc.GL730

OVERNIGHT DELIVERY

Autoranging Digital Multimeter

Our previous autoranging DMM sold for $119, in our opinion this new model is far better, and right now it's $50 cheaper!

Features: • 3.75 digit LCD with a digital bargraph display • autoranging with manual override • display hold function • audibly continuity buzzer • diode check • up to a huge **15A** current measuring capacity • auto DC/AC detect with manual override • fuse protection • **supplied complete with a shock-proof rubber holster and flexible test leads!**

Specifications:
DC Voltage: 320mV, 3.2V, 32V, 320V, 600V
AC Voltage: 3.2V, 32V, 320V, 600V
DC/AC Current: 320µA, 3200µA, 32mA, 320mA, 15A
Resistance: 320Ω, 3.2k, 32k, 320k, 3.2M, 320M

Q 1072 Normally $99, NOW **$69**

Fantastic Value! 3.75 digit DMM with bargraph and autoranging! Includes rubber holster and test leads!

PC FM Radio Receiver

Turn Your PC Into a FM Radio! Simple "Plug-In" Installation.

AS FEATURED IN SILICON CHIP MAY '97 PRODUCT SHOWCASE!

A plug-and-play FM broadcast band receiver for your multimedia PC! Plugs into the RS-232 serial port (DB25), and has an audio output which connects to your PC's sound card. The Windows-based tuner program includes presettable memories for your favourite stations, seek tuning and even a frequency display! Once tuned, the radio will operate in the background while you use the computer for other tasks. The software can be closed while the radio continues playing, saving RAM. Package includes radio module, stereo 3.5mm jack audio lead, antenna and software. No external power required, covers 87.5MHz to 108MHz FM band. 40mV rms output at 60dB S/N ratio. Requires 386SX or better CPU, sound card and Windows 3.1/'95 OS.

A 0900 Normally $49, NOW **$39**

Includes Windows Based Control Software!

NiCad Rechargeable Batteries

With Christmas coming up, chances are you'll be paying out for batteries to power the presents! These NiCad rechargeable cells will eventually pay for themselves, and can provide hundreds of recharges if cycled periodically (see our A 0280). They can be used in just about any battery powered appliance.

S 4705 700mAh AA Cell Normally $2.30 ea,
NOW **$2** ea, 4 and up, or **$1.60** ea, 10 & up

S 4710 1500mAh C Cell Normally $4.95 ea,
NOW **$4** ea, 4 and up, or **$3.50** ea, 10 & up

S 4715 1500mAh D Cell Normally $5.25 ea,
NOW **$4** ea, 4 and up, or **$3.75** ea, 10 & up

S 4720 100mAh 9V Cell Normally $10.95 ea,
NOW **$8** ea, 2 and up, or **$7.50** ea, 4 & up

High Quality MINAMOTO brand! Get up to 1000 recharges or more! Australia's LOWEST prices!

REGULATED Multi-Voltage Plug Pack

A *fully regulated* (not just filtered!) plugpack suitable for powering video games, portable CD players, walkmans, or other sensitive devices. Unregulated plugpacks can vary in output voltage by up to 30%, which can cause damage to some equipment! This regulated plugpack has 6, 9 and 12V DC voltage outputs at up to 500mA.

M 9516 Normally $28.95, NOW **$19.95**

Internal regulator provides precise voltage output and smooth DC for sensitive devices!

Mini Toggle Switches

WHAT A BARGAIN! Stock up on these high quality SPDT mini toggle switches. As used by manufacturers Australia-wide, and in many of our own kit sets and products. Rated at 5A @ 125VAC or 28VDC.

Save 30% in packs of 10!

S 1310 Normally $2.15 ea, NOW **$15** pk 10

Keychain Laser Pointer

This laser pointer weighs only 45g, and comes with a keychain. Measuring only 61mm long by 14mm in diameter, it's not much bigger than many keys! It emits a very intense beam that can travel up to 50m, and projects a bright red dot onto the target is it aimed at. It's ideal for lectures, guided tours, seminars, building sites etc, and it's much less intrusive than a normal stick pointer! Uses two button batteries (included).

A 0201 WAS $69, NOW **$59**

Great for tours, lectures, seminars etc!

Battery Charger & Refresher

Charges or discharges Nickel Cadmium and Nickel Metal-Hydride cells, and refreshes up to four carbon or alkaline cells, or up to two 3V lithium cells. Accepts AA and AAA sizes of all capacities. Features LED charging status and cell type indicators. Discharger operates at the push of a button, and if used to "cycle" batteries regularly, it can reduce memory effects in rechargeable cells, giving longer service life. Powered by 12V DC, either from M 9664 plug pack (not included) or car battery.

A 0280 **$39.95**
M 9106 12V 500mA Plug Pack **$22.95**

Keep your rechargeables in top condition and extend their service life! Also Includes Alkaline Refresh Function.

High Power Siren

Strong & durable construction, makes this siren ideal for car, boat or home installation. Includes a handy bracket for surface mounting. **Extremely loud 120dB output.** Requires 12V DC @ 300mA. Dimensions 100Ø x 125L mm.

S 6130 Was $30.95,
NOW **$19.95**

Massive 120dB Output! Great for car & house security systems or alarm panels!

Pocket Size DMM

This mini DMM has test leads which are hard wired to the unit and slot into an integral clip on the side of the unit. No more lost test leads! Features 3.5 digit display, auto power off, battery check and diode test function. Just the shot for the student lab kit or enthusiast toolkit! **Ranges:**
DC V: 2V, 20V, 200V, 500V
AC V: 200V, 500V
Resistance: 2k, 20k, 200k, 2M
DC A: 200mA (Fused)
Hfe: 0 - 1000, **Batt. check:** 1.5V and 9V

Q 1030 Normally $29.95
NOW ONLY **$14.95**

YES! A 15 Range DMM for UNDER $15! But Be Quick! They're going FAST!

Professional 5 Sector Digital Alarm System with Auto Dialler

This system is the same type used by commercial alarm companies to protect both residential and business premises across Australia.

Improve the security of your home or business with this micro-processor controlled alarm, & get $100 worth of accessories FREE!!

Incorporating an inbuilt ***Austel approved*** auto-dialler, this alarm can be configured to automatically dial two preset numbers in the event of an alarm, i.e. it could ring a neighbour or a monitoring company. The main controller circuitry is housed in a sturdy steel cabinet, which can house an optional back up battery if required. The keypad control unit is generally located at the front door for easy access to arming and disarming of the system. The entire system is controlled and programmed via this keypad. A combination of normally open and normally closed sensors can be used on any zone. **Features:** • master code and three adjustable user codes • monitor function which tests battery backup and mains failure • four sectors with programmable attributes plus 24Hr zone • extensive noise protection circuitry and end of line resistors for added security • once triggered the alarm has the option of a silent alarm plus dialout • quick arming option • zone bypassing for sectors which are false triggering • bell test - to test the external sirens without dialling out • door chime mode for entry/exit paths • battery backup • home or away operation • accessible alarm memory for confirming which sectors were triggered • separate instruction and installation manuals • 12 months warranty

S 5490 **$279**

Pulse Count PIR Detector

Buy a set of 4 & SAVE!

Incorporates a pulse count circuit to minimise false triggering, "sense" LED, tamper switch and relay output. Range up to 12m horizontal when mounted 2m from the floor, with a 90° detection angle. Coverage can be changed by sliding the PCB up or down in the case. Can be configured as Normally Open or Normally Closed with . Suits the S 5490 alarm or many other security systems.

S 5315 Was $49, NOW **$39**, or Buy 4 for **$140**

6 Core Security Cable

W 2356 **$1.30** per metre
or **$170** 200m Roll

NB: 200m is enough to wire an average four bedroom home

Siren Cover

S 5460 **$28.95** ea

Super Bonus Deal!

Purchase a S 5490 5 Sector Alarm system before October 31st, and we'll supply ***$100*** worth of accessories ***FREE!!!***

Bonus package includes M 9127 Plugpack, S 5075 Backup battery, S 6130 Siren, S 5445 Blue Strobe, 2 Large alarm stickers and 4 window stickers!

WARNING
ALTRONICS SURVEILLANCE ALARM SYSTEM FITTED HERE

ALTRONICS

Fax Order Line: (08) 9328 3487

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ALTRONICS COMPONENTS

ALTRONICS Order Line: (08) 9328 3487

5 Digit Tacho Kit

NEW!

At last! A useful digital tacho with super-fast update time and 1 rpm resolution!

(See EA Oct '97) A fantastic, high-tech addition to your car's dashboard. This 5 digit tachometer features a crystal timebase for super-accurate readings, a 0.25 second update time and a resolution of ONE rpm. It also has a dimmable display, leading zero blanking, last digit "0" lock (stops "rolling" display), and can read to 60,000rpm if required. Not even rotaries rev *that* high! Can be configured for ignition coil input (3V) or low level input (1V) from an existing tacho. If you're after a *useable* digital tacho for street or circuit applications, this is it! *Note: Case NOT included.*

K 4325 **$79**

Multi-Spark Capacitor Discharge Ignition Kit

NEW!

Provides multiple sparks for a cleaner, extended mixture burn, increasing power and efficiency!

(See SC Sept '97) Why multi-spark? Fuel burns more thoroughly with a multiple spark and can therefore improve engine performance especially in two stroke motors, older engines and high performance four strokes. The circuit also fires fouled plugs, thereby reducing the time between plug replacement. If you own a go-kart, why not boost it's performance with this circuit? • Operates on reluctor, points or hall effect signals • Regulated 300V output (constant spark energy) • Twin inputs for twin coil systems • Output for electronic tachometers • Usable to beyond 1000 sparks/second (equals 15000 rpm for V8) • Includes all parts except the pickup circuit. • Supplied in an attractive black powder coated metal- automotive project box

K 4370 **$110**

500W Amplifier Module Kit

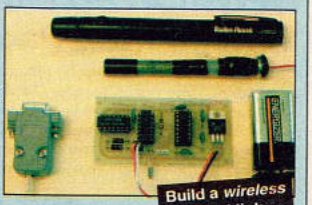
(See SC Aug '97) *What a Beast! 500W into 4 ohms!*

MASSIVE 500W! Great for DJ amps, component subwoofers, instrument amplifiers, even PA systems!

Just the thing to power dedicated subwoofers, DJ, PA or party amps or the like. Silicon Chip claims it's the biggest amplifier ever published in a magazine and they'd be right. *Features* • 500W RMS into 4 ohms , 278W into 8 ohms (-0.3dB @ 20hz and 20KHz) • Input sensitivity 1.43V (at full power into 8 ohms) • Distortion typical less than 0.01% • Signal to noise 117db un-weighted 122db A-weighted • Supplied with the PCB and the components to populate the board, requires a heatsink and power supply *(requires ±80V DC)*

K 5190 **$230**

Laser Transceiver Kit



Build a wireless serial link between two PCs!

(See EA, Aug '97) Utilising a MAX232 IC and a clever little circuit to strobe the laser and interpret the received signal, this kit allows two computers to communicate over distances of up to 50m or more (depending on the laser used) via their RS232 ports. Supplied shortform with the components to build the transceiver.

Laser pointer extra, see our A 0201, this month only $59.

K 2860 **$21.95**

Laser Transmitter Kit

(See EA, Aug '97) The transmitter can be used for light effects, one way (half duplex) communication with the PC and experimentation. With RS232 input and TTL input capability. Supplied shortform with components to build the transmitter only.

K 2862 **$15.95** A 0201 Laser Pointer **$59**

PC Stepper Motor Controller

NEW!

Start experimenting with robotics! Allows accurate control over a stepper motor.

This kit allows control over a single stepper motor via the parallel port of a PC computer. Uses include control of robot projects or any other application where a precise number of turns or revolutions is required (with a little imagination and experimentation maybe a turns winder for transformers). Daisy chained together, control of up to eight motors is possible with one PC. Supplied in short form and requiring a 12V DC power supply this project comes with all the components and PCB to begin experimentation.

K 2835 **$32.50**

Mini-Strobe Kit

(See EA, Aug '97) Taking advantage of a new range of white LED's this mini strobe can be used to measure the RPM of any thing that rotates or moves. From 400 - 4000 RPM , the strobe rate can be increased until the object motion appears to stop, then the RPM can be read off the scale on the front panel. Supplied with a project box with silk screened front panel, the kit has provision on the PCB to expand with the addition of more LED's, variable pulse width and an addition to allow the measurement of pulse width on a frequency counter. Requires 9V battery (not included).

K 5785 **$21.50**

Video Enhancer & Stabiliser

NEW!

(See EA, Nov '97) Ever transferred your home or holiday movies to VHS and found the picture quality is degraded? This little enhancer will spruce up the video signal, and can even improve the quality of poorly-recorded video. It also has an image stabiliser which removes all the invisible overheads from video signals, such as teletext data, leavinbg a clean PAL composite signal. *If you're into making your own movies or taking some holiday footage, this is a very useful accessory!*

K 5830 **$59**

Megger Meter Kit

(See EA May '89) This design of an electronic meg-ohm meter features a dual voltage of 500 and 1000V with a large scale meter. It can resolve resistance from 1M to 200M ohm which is ideal for insulation testing of cable, transformers, motor windings, HT circuits etc. ***A must for checking earth leakage! Build your own megger meter and save $$$!!***

K 2555 Was $79, Now JUST **$69**

Over 1000 Sold!

ALTRONICS

174 Roe St. Perth W.A. 6000
Phone (09) 328 1599, **Fax** (09) 328 3487
MAIL ORDERS C/- P.O. Box 8350
Perth Business Centre, W.A. 6849

We welcome ... bankcard MasterCard VISA

Standard Delivery & Packing Charge: $4.00 to 500gms, $5.50 500gms-1 kg, $8.00 1kg-5kg. Where possible we process your order the day received and despatch via Australia Post. Allow approx 9 days from day you post order to when you receive goods.

Overnight Jetservice: Up to 3kg is $9.50, 3kg to 5kg is $16.00—We will process your order the day received (if placed before 2.00PM WST) and despatched for delivery the next day. Country areas please allow an additional 24-48 hours.

Heavy Service: All orders of 10kgs or more must travel Express Road—Please allow up to 7 days for delivery. $12.00 to 10kgs. $15.00 over 10kgs. **Insurance:** As with virtually every other Australian supplier, we send goods at consignee's risk. Should you require insurance cover against loss or damage please add $1.00 per $100 of order value (minimum charge $1). When phone ordering please request "Insurance". **Altronics Resellers:** Chances are there is an Altronics Reseller right near you—check this list or phone us for details of the nearest dealer. Blue Ribbon Dealers are highlighted with a ●. These dealers generally carry a comprehensive range of Altronic products and kits or will order any required item for you.

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LONSDALE	Force Electronics ●	(08) 83260901
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Silicon Chip Bookshop

Newnes Guide to Satellite TV

Installation, Reception & Repair. By Derek J. Stephenson. First published 1991, reprinted 1994 (3rd edition).

This is a practical guide on the installation and servicing of satellite television equipment. The coverage of the subject is extensive, without excessive theory or mathematics. 371 pages, in hard cover at $55.95.

Guide to TV & Video Technology

By Eugene Trundle. First published 1988. Second edition 1996.

Eugene Trundle has written for many years in *Television* magazine and his latest book is right up date on TV and video technology. 382 pages, in paperback, at $39.95.

Servicing Personal Computers

By Michael Tooley. First published 1985. 4th edition 1994.

Computers are prone to failure from a number of common causes & some that are not so common. This book sets out the principles & practice of computer servicing (including disc drives, printers & monitors), describes some of the latest software diagnostic routines & includes program listings. 387 pages in hard cover at $59.95.

The Art of Linear Electronics

By John Linsley Hood. Published 1993.

This is a practical handbook from one of the world's most prolific audio designers, with many of his designs having been published in English technical magazines over the years. A great many practical circuits are featured – a must for anyone interested in audio design. 336 pages, in paperback at $55.00.

Digital Audio & Compact Disc Technology

Produced by the Sony Service Centre (Europe). 3rd edition, published 1995.

Prepared by Sony's technical staff, this is the best book on compact disc technology that we have ever come across. It covers digital audio in depth, including PCM adapters, the Video8 PCM format and R-DAT. If you want to understand digital audio, you need this reference book. 305 pages, in paperback at $59.00.

Power Electronics Handbook

Components, Circuits & Applications, by F. F. Mazda. Published 1990.

Previously a neglected field, power electronics has come into its own, particularly in the areas of traction and electric vehicles. F. F. Mazda is an acknowledged authority on the subject and he writes mainly on the many uses of thyristors & Triacs in single and three phase circuits. 417 pages, in soft cover at $59.95.

Surface Mount Technology

By Rudolph Strauss. First published 1994.

This book will provide informative reading for anyone considering the assembly of PC boards with surface mounted devices. Includes chapters on wave soldering, reflow soldering, component placement, cleaning & quality control. 361 pages, in hard cover at $99.00.

Radio Frequency Transistors

Principles & Practical Applications. By Norm Dye & Helge Granberg. Published 1993.

This book strips away the mysteries of RF circuit design. Written by two Motorola engineers, it looks at RF transistor fundamentals before moving on to specific design examples; eg, amplifiers, oscillators and pulsed power systems. Also included are chapters on filtering, impedance matching & CAD. 235 pages, in hard cover at $95.00.

Electronics Engineer's Reference Book

Edited by F. F. Mazda. First published 1989. 6th edition.

This just has to be the best reference book available for electronics engineers. Provides expert coverage of all aspects of electronics in five parts: techniques, physical phenomena, material & components, electronic design, and applications. The sixth edition has been expanded to include chapters on surface mount technology, hardware & software design, semi-custom electronics & data communications. 63 chapters, soft cover at $120.00.

Audio Electronics

By John Linsley Hood. Published 1995.

This book is for anyone involved in designing, adapting and using analog and digital audio equipment. Covers tape recording, tuners & radio receivers, preamplifiers, voltage amplifiers, power amplifiers, the compact disc & digital audio, test & measurement, loudspeaker crossover systems and power supplies. 351 pages, in soft cover at $55.00.

Understanding Telephone Electronics

By Stephen J. Bigelow. Third edition published 1997 by Butterworth-Heinemann.

This is a very useful text for anyone wanting to become familiar with the basics of telephone technology. The 10 chapters explore telephone fundamentals, speech signal processing, telephone line interfacing, tone and pulse generation, ringers, digital transmission techniques (modems & fax machines) and much more. Ideal for students. 367 pages, in soft cover at $49.95 (please note price rise).

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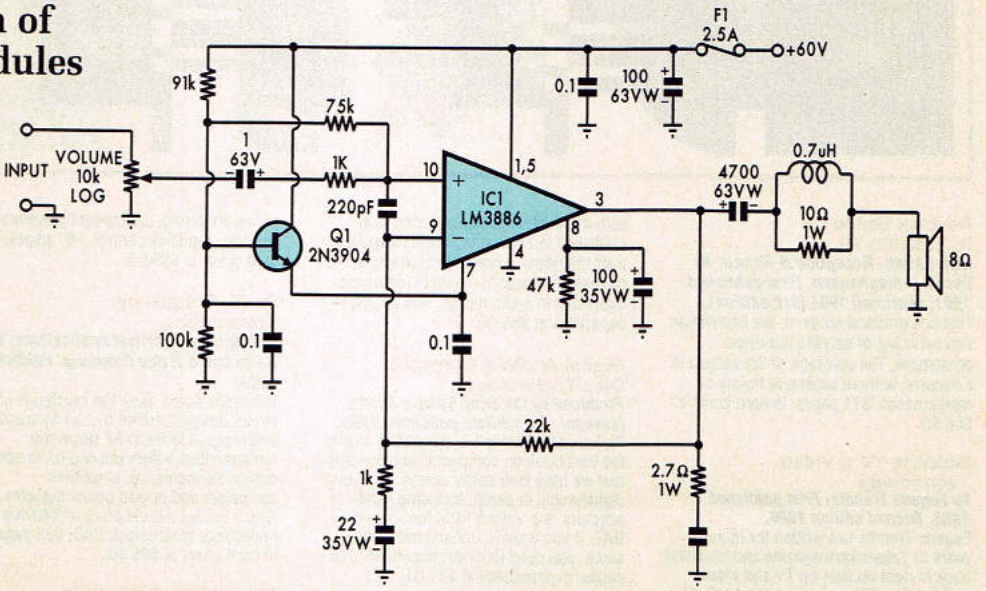
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Single supply version of LM3876/LM3886 modules

The LM3876 50W amplifier module published in March 1994 and the stereo 60W/channel LM3886 amplifier module published in February 1995 have proved to be very popular and reliable. However, a number of readers restoring older amplifiers have asked about the possibility of producing single supply versions. The reason for this that most solid state commercial amplifiers produced before about 1980 used single rail amplifiers.

The method for running any amplifier module of this sort from a single supply rail is to provide a voltage divider to produce a half-supply input bias, a lower impedance "half supply" reference for the normal amplifier input ground and a large electrolytic capacitor at the output to block the resulting half-DC supply from the loudspeaker.



The revised circuit shows the LM3886 but the same circuit components can be used with the LM3876. A voltage divider consisting of 91kΩ and 100kΩ resistors provides a nominal "half supply" to bias the non-inverting input (pin 10) via a 75kΩ resistor. Also fed from this voltage divider is emitter follower Q1 which provides the ground reference at pin 7.

While it may be possible to install the additional input bias components on the PC board, the 4700µF output coupling capacitor will probably need to be mounted off the board.

SILICON CHIP

Square wave pulse generator

Originally designed as part of a calibration circuit for EMI noise spectrum measurements, this circuit should prove useful as a general purpose square wave generator.

It generates square wave output signals at a calibrated frequency selectable from 0.5Hz to 100kHz in 1-2-5 steps. The frequency at each step is variable (uncalibrated) over a range of approximately 5:1, giving a total frequency range from 0.5Hz to over 500kHz (around 700kHz in the prototype).

The frequency stability appears to be better than 0.5% at any calibrated position, although this has not been tested over the full operating temperature range.

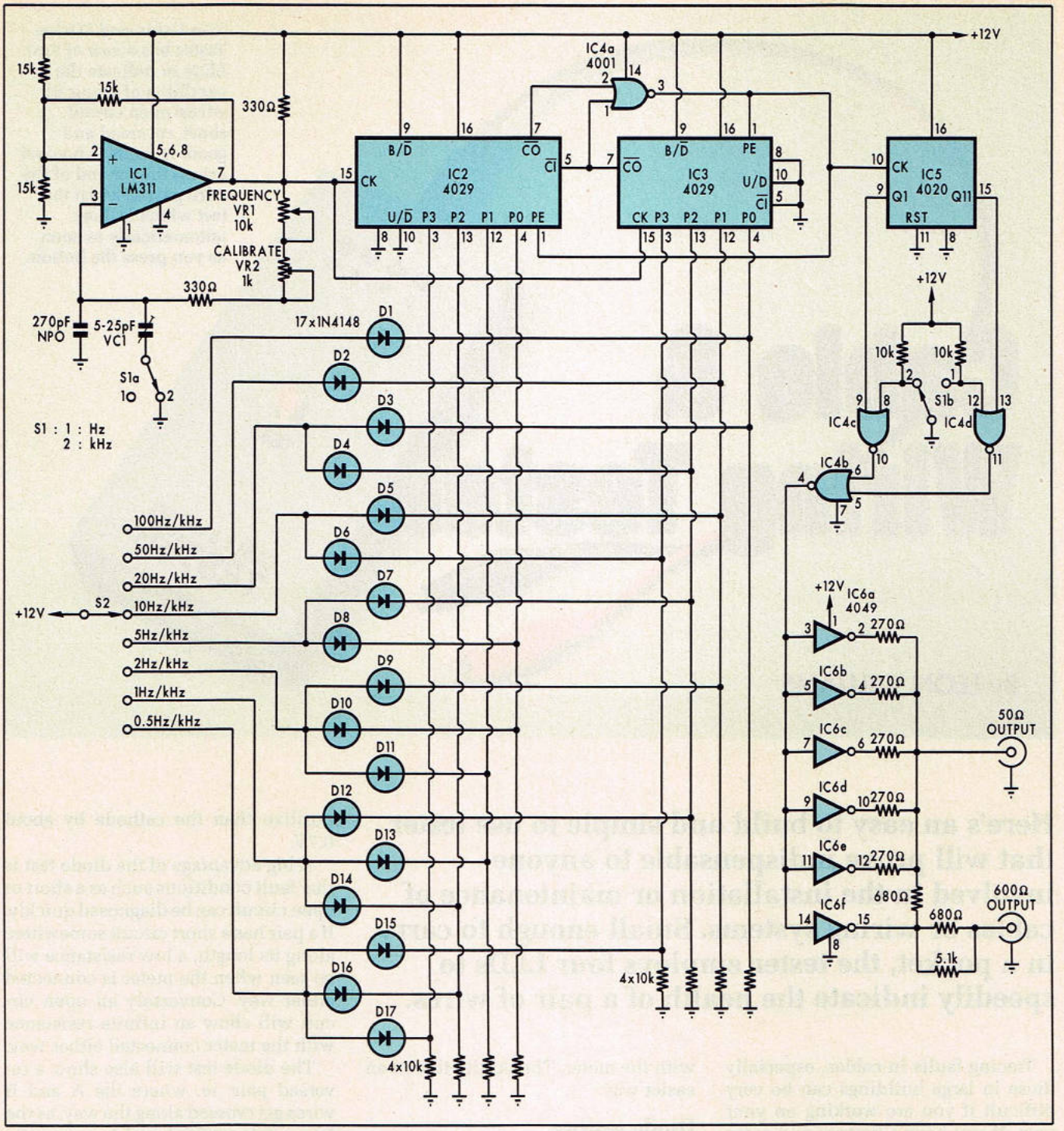
IC1 and associated components form a square wave oscillator operating in the range from 200kHz to over 1MHz. This is divided by counters IC2 and IC3 by one of eight selectable ratios in a 1-2-5 sequence as set by diode matrix D1-D17 and switch S2. The frequency is further divided by IC5 by 2 or 2024, depending upon the

Changing the Neon Tube Modulator

A number of readers have asked us how to modify the Neon Tube Modulator which was published in the May 1997 issue so that the bass notes actually cause the neon tube to light. This is the opposite modulation to the existing circuit.

The simplest solution is to replace Q2, the BD140 control transistor, with a BD139 and swap the emitter and collector leads. With this modification the time that the tube is illuminated may not be long enough. This on-time can be lengthened by increasing the 150kΩ resistor, the increase being directly proportional to the resistor value. If necessary the 0.1µF capacitor from pin 6 of IC1 can also be increased to 0.22µF or 0.47µF.

SILICON CHIP



output selected by S1b. IC4b-IC4d pass the selected frequency to output buffer IC6.

As shown, there are two outputs: (1) a low impedance 50Ω output and (2) a high impedance 600Ω output, both providing 12V peak-to-peak with no load. Typically, one output might be used as the "main" output while the other might be used as a reference for an oscilloscope display or fed to a frequency counter. If desired, an adjustable attenuator could be provided between the output buffer (IC6) and either of the output sockets.

The output frequency is calibrated in either "Hz" or "kHz", depending on the setting of switch S1. Variable capacitor C2 is used to adjust the frequency in the "kHz" range to compensate for the fact that the division ratios obtainable with IC5 at the selected outputs are not in an exact 1000:1 ratio.

To calibrate, first set S1 to "Hz" and S2 to "100". Set VR1 to its minimum frequency position and adjust VR2 for an output frequency of 100.0Hz. Next, set S1 to the "kHz" position and adjust C2 for an output frequency of 100.0kHz.

H. Nacinovich,
Gulgong, NSW. ($60)

Cable & Wiring Tester

This Cable and Wiring Tester has a row of four LEDs to indicate the condition of a pair of wires: open circuit, short, reversed and good. A diode is hooked across the far end of the wire pair to assist the test which is done automatically as soon as you press the button.

By LEON WILLIAMS

Here's an easy to build and simple to use tester that will prove indispensable to anyone involved in the installation or maintenance of cables or wiring systems. Small enough to carry in a pocket, the tester employs four LEDs to speedily indicate the health of a pair of wires.

Tracing faults in cables, especially those in large buildings can be very difficult if you are working on your own. If you have a partner and some form of communication, you can use a multimeter set to measure resistance at your end while you get your partner to apply a short circuit and then remove it. With the short removed the meter should show an infinite resistance, and with the short applied a low resistance.

This is obviously difficult on your own, as you would have to travel between ends to place the short and remove it in between taking readings with the meter. Thankfully there's an easier way.

Diode testing

A technique that has been used for a long time to test cable pairs is to place a diode across the A and B wires of the pair at the remote end. When a meter is placed across the pair at the local end, a low resistance will be obtained with the meter leads connected one way and a very high (ideally infinite) resistance with the leads reversed. This happens because the diode only passes current in one direction; ie, when the anode is more positive than the cathode by about 0.7V.

A big advantage of the diode test is that fault conditions such as a short or open circuit can be diagnosed quickly. If a pair has a short circuit somewhere along its length, a low resistance will be seen when the meter is connected either way. Conversely an open circuit will show an infinite resistance with the meter connected either way.

The diode test will also show a reversed pair; ie, where the A and B wires get crossed along the way, as the low resistance/high resistance results will be opposite to those for a good pair. This goes to prove that the best ideas are sometimes the simplest. Fig.1 illustrates the four common pair combinations and the results obtained.

Easy to use

Carrying around an expensive multimeter, continuously turning it on and off and reversing the leads to test pairs is tedious. With the Cable and Wiring tester all you have to do is connect the

two test leads to the pair under test and press the Test button. The tester will automatically test the pair and display the result on one of four LEDs.

The orange LED (O) will flash to indicate an open circuit and the yellow LED (S) will flash if the pair is short circuit. A pair that is reversed will cause the red LED (R) to flash, while a pair that is in good condition will cause the green LED (G) to flash. Of course you will need to connect the diode at the other end of the pair you are testing.

Circuit description

The Cable and Wiring tester works just like the manual diode testing shown in Fig.1 but it does it automatically in two phases before it displays the result. I will refer to these as phase 1 and phase 2. Fig.2 shows the circuit.

An oscillator is formed with IC2c, one section of a 40106 hex Schmitt trigger inverter, a 330kΩ resistor and a 0.22µF capacitor. It produces a square wave output with a frequency of about 20Hz. IC2d, a 100kΩ resistor and a 0.1µF capacitor form a delay circuit. The output at pin 10 of IC2d is a delayed and inverted replica of the output from IC2c.

The reason for the delay circuit is to separate the sample and display pulses from the unstable periods when the analog switches are swapping the polarity of the line. The oscillator controls the overall operation of the tester and when its output is low, it is in phase 1, and when its output is high, it is in phase 2.

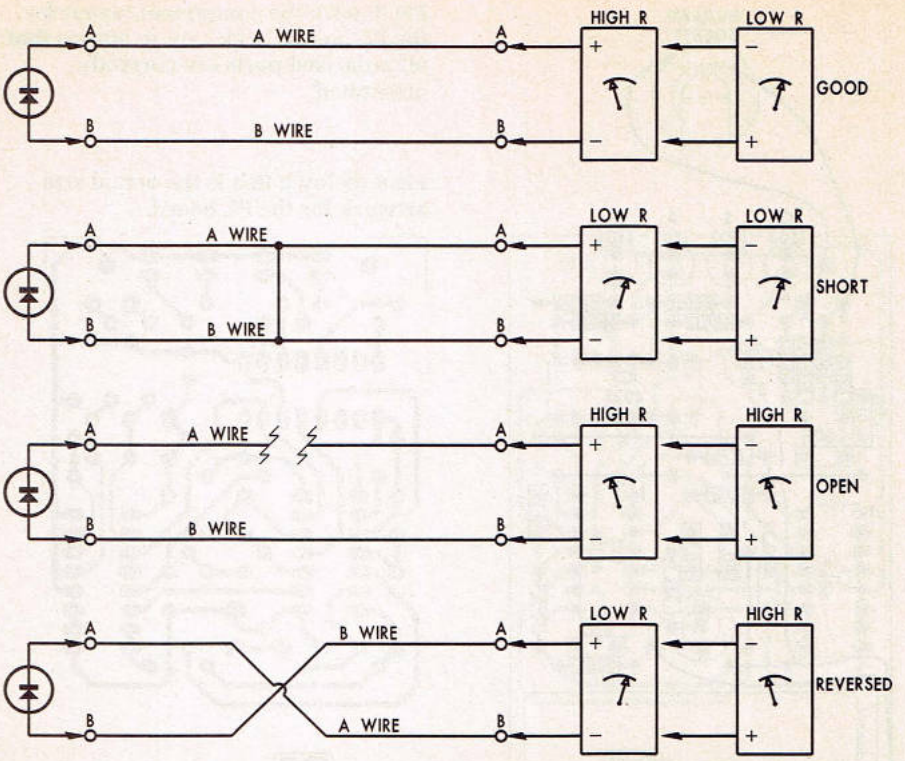


Fig.1: this series of the diagrams illustrates the method of testing a cable pair with a multimeter and a diode connected to the far end. The Cable and Wiring Tester runs through these tests automatically.

In phase 1, analog switch IC1a connects wire A of the pair to pin 1 of IC2a, while IC1b connects wire B to ground. If the pair is good (ie, not reversed) and the diode is connected

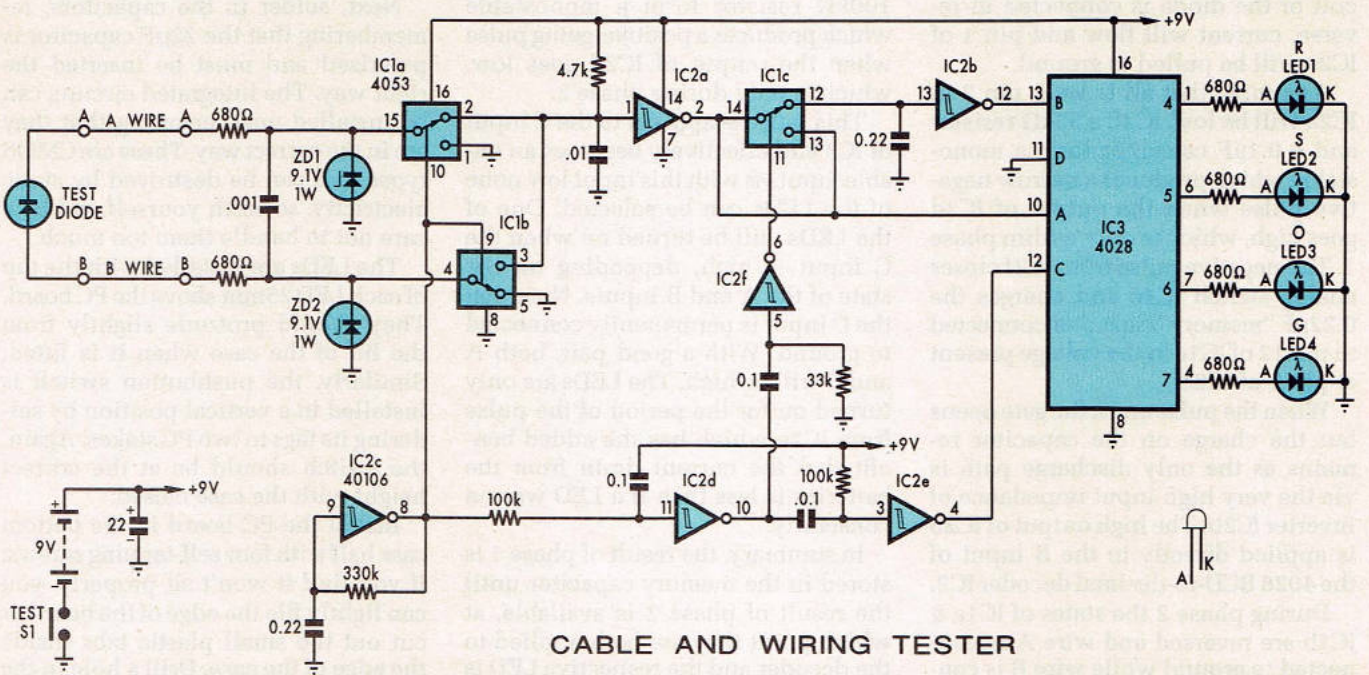


Fig.2: the Cable and Wiring Tester works by alternately applying DC voltage to a cable pair in one direction and then the other. The four possible conditions are indicated by the LEDs.

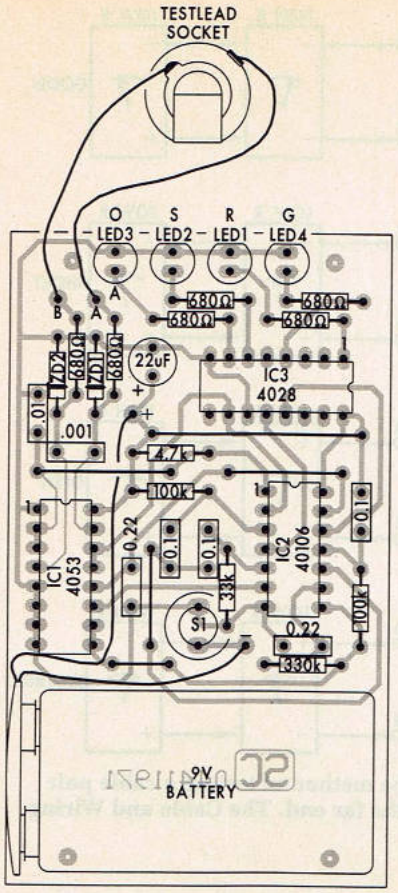
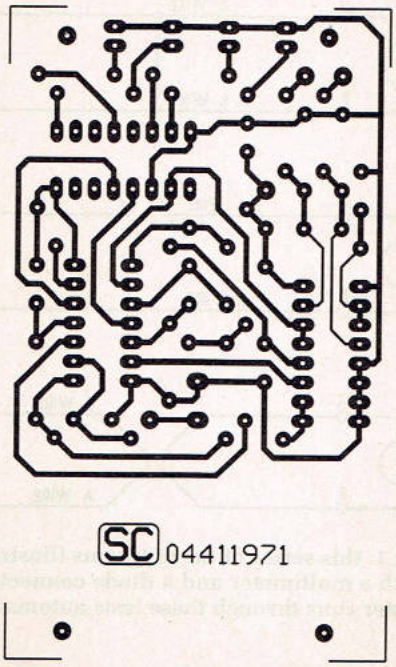


Fig.3 (left): the component layout for the PC board. Take care to ensure that all polarised parts are correctly orientated.

Fig.4 (below): this is the actual size artwork for the PC board.



with its cathode to wire A, no current will flow through this circuit and pin 1 of IC2a will be pulled high by the 4.7kΩ resistor. If the pair is short circuit or the diode is connected in reverse, current will flow and pin 1 of IC2a will be pulled to ground.

Assuming that all is well, pin 2 of IC2a will be low. IC2f, a 33kΩ resistor and a 0.1µF capacitor form a monostable which produces a narrow negative pulse when the output of IC2d goes high, which is only within phase 1. The negative pulse from IC2f closes analog switch IC1c and charges the 0.22µF "memory" capacitor connected to pin 12 of IC1c to the voltage present at pin 2 of IC2a.

When the pulse ends, the gate opens but the charge on the capacitor remains as the only discharge path is via the very high input impedance of inverter IC2b. The high output of IC2b is applied directly to the B input of the 4028 BCD-to-decimal decoder IC3.

During phase 2 the states of IC1a & IC1b are reversed and wire A is connected to ground while wire B is connected to pin 1 of IC2a. With a good pair, current will flow through the circuit and pin 1 of IC2a will be pulled to ground. The output (pin 2) of IC2a is connected directly to the A input of IC3. IC2e, a 0.1µF capacitor and a 100kΩ resistor form a monostable which produces a positive-going pulse when the output of IC2d goes low, which is only during phase 2.

This pulse is applied to the C input of IC3 and effectively becomes an enable input, as with this input low none of the LEDs can be selected. One of the LEDs will be turned on when the C input is high, depending on the state of the A and B inputs. Note that the D input is permanently connected to ground. With a good pair, both A and B will be high. The LEDs are only turned on for the period of the pulse from IC2e which has the added benefit that the current drain from the batteries is less than if a LED was on constantly.

In summary, the result of phase 1 is stored in the memory capacitor until the result of phase 2 is available, at which point they are both applied to the decoder and the respective LED is turned on.

Since high voltages could be present on the wires being tested, most likely in the form of static charges, each input is protected with a series 680Ω resistor and a 9.1V zener diode. A .001µF capacitor is also connected between the two inputs to shunt any RF signals that might otherwise be picked up by the wires under test.

The tester operates from a standard 9V battery which should last quite a long time. Note that the Test switch is also the power switch and is connected in the negative supply lead instead of the positive supply lead as is normal practice. This was done simply because it made the PC board layout easier.

Construction

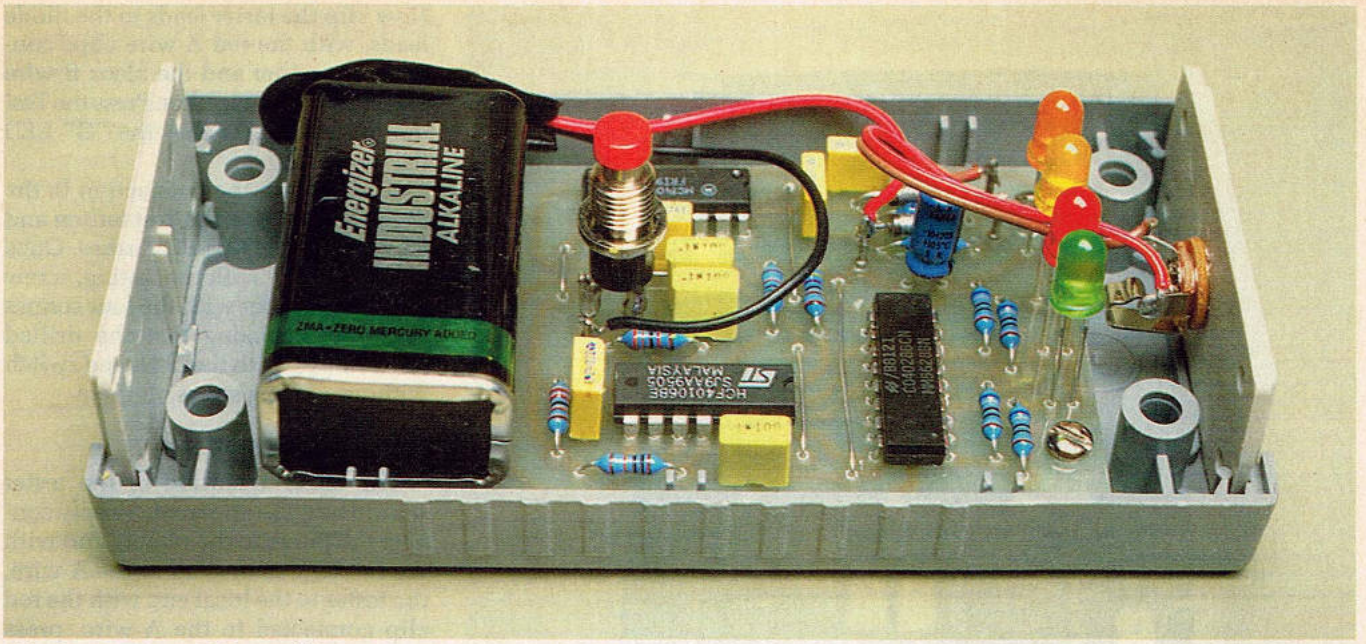
The Cable and Wiring Tester is mounted in a small plastic case with a row of four LEDs and a pushbutton on top. At one end is a 3.5mm jack socket to enable connection to a pair of wires. Pressing the button flashes one of the four LEDs depending in the test condition: Open (Orange); Short (Yellow); Reversed (Red); and Good (green).

All the components apart from the test socket are mounted on a single-sided PC board. Fig.3 shows the wiring diagram. Begin construction by soldering in the five tinned copper wire links, ensuring that they are straight and lay flat on the board. Follow this with the resistors, the zener diodes and the PC stakes.

Next, solder in the capacitors, remembering that the 22µF capacitor is polarised and must be inserted the right way. The integrated circuits can be installed next, ensuring that they are in the correct way. These are CMOS types and can be destroyed by static electricity, so earth yourself and take care not to handle them too much.

The LEDs are installed with the top of each LED 25mm above the PC board. They should protrude slightly from the lid of the case when it is fitted. Similarly, the pushbutton switch is installed in a vertical position by soldering its tags to two PC stakes. Again, the switch should be at the correct height with the case closed.

Install the PC board in the bottom case half with four self-tapping screws. If you find it won't sit properly, you can lightly file the edge of the board or cut out the small plastic tabs inside the edge of the case. Drill a hole in the centre of the top endplate and mount the 3.5mm test socket. Place the two



The four LEDs and the pushbutton switch are stood off the board so that they protrude through the lid of the case.

end plates in the slots on the bottom half of the case. The bottom half has four holes for the case mounting screws while the top half has threaded brass inserts.

Solder two wires from the socket to the PC stakes on the PC board. Now solder in the battery clip and trim the length of the wires so that they sit neatly with the battery positioned as shown in the photographs. You may find it necessary to cut off some of the plastic tabs on the inside of the top half to clear the battery clip when the two halves are screwed together. Drill the four holes for the LEDs and for the test switch in the top half of the case. The positions for these can be quite easily found by firstly making measurements with a ruler and then marking with a pencil before drilling.

The test lead is made from a short length of figure-8 cable. The type used in the prototype was coloured red and black. I soldered the red A wire to the centre pin of the 3.5mm plug and the

Parts List

1 PC board, code 04411971, 51 x 88mm
1 plastic case, 120 x 60 x 30mm
1 3.5mm mono phono socket
1 3.5mm mono phono plug
2 small black alligator clips
2 small red alligator clips
1 normally open pushbutton switch
6 PC stakes
1 9 volt battery clip
4 No. 4 x 6mm self-tapper screws

Semiconductors
1 4053 triple analog selector (IC1)
1 40106 or 74C14 hex Schmitt trigger (IC2)
1 4028 BCD-to-decimal decoder (IC3)
2 9.1V 1W zener diodes (ZD1,ZD2)
1 1N4004 diode (remote test diode)
1 5mm red LED (LED1)
1 5mm yellow LED (LED2)
1 5mm orange LED (LED3)
1 5mm green LED (LED4)

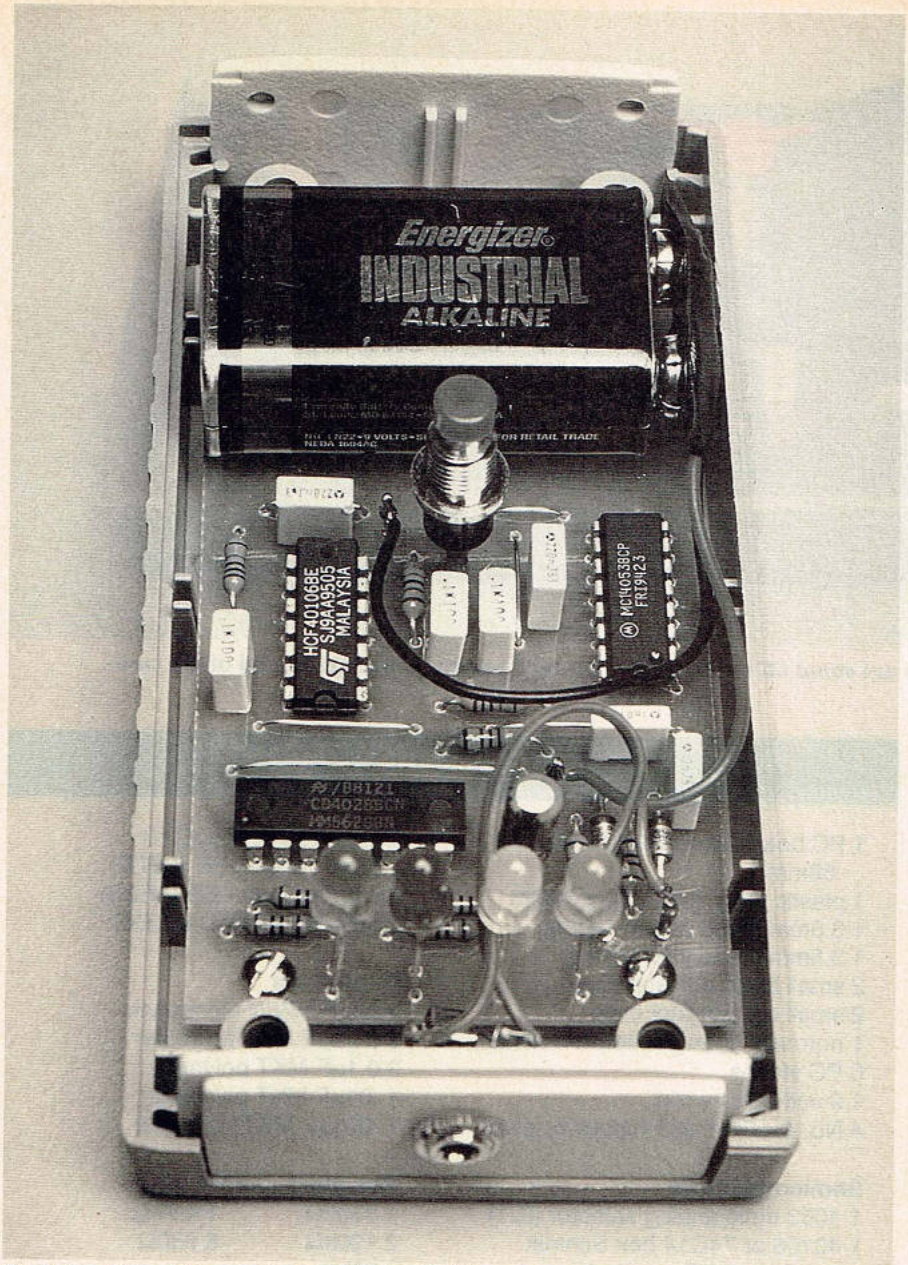
Capacitors
1 22µF 16VW electrolytic
2 0.22µF MKT polyester
3 0.1µF MKT polyester
1 .01µF MKT polyester
1 .001µF MKT polyester

Resistors (0.25W, 1%)
1 330kΩ
2 100kΩ
1 33kΩ
1 4.7kΩ
6 680Ω

Miscellaneous
Tinned copper wire, hookup wire, figure-8 cable, small piece of scrap stripboard, heatshrink tubing

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	330kΩ	orange orange yellow brown	orange orange black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	6	680Ω	blue grey brown brown	blue grey black black brown



Another view of the prototype Cable & Wiring Tester. Power comes from an internal 9V battery.

black B wire to the ground pin. To finish the lead, solder a red alligator clip to the red wire and a black alligator clip to the black wire.

The diode assembly can be made next. It simply comprises a diode soldered to a length of figure-8 cable as before. Its anode is soldered to the black wire and the cathode to the red wire. I used a scrap piece of strip board to give the assembly some mechanical strength and then covered it with heatshrink sleeving to prevent accidental shorting. The red alligator clip is soldered to the red wire and the black alligator clip to the black wire.

Finally, fit a good 9V battery into the case.

Testing

With the assembly complete, press the test switch briefly and check that the "O" LED flashes at about 20Hz. If it does, you can proceed with the rest of the testing. If it doesn't work, have a good look at the assembly again and check it for construction errors.

Plug the test lead into the socket and connect the two alligator clips together. Press the Test button and check that the "S" LED flashes to indicate that the wires are shorted together.

Now clip the tester leads to the diode leads, with the red A wire clips connected together and the black B wire clips connected together. Press the Test button and verify that the "G" LED flashes.

Now reverse the connection to the diode leads, press the Test button and check that the "R" LED flashes. Once you are happy with the testing, screw the case together with the four screws supplied, checking that the drilled holes line up with the LEDs and switch without placing stress on them.

Using the tester

The basic operation of the tester should be quite apparent. Simply connect the diode to the remote end with the red clip connected to the A wire, the tester to the local end with the red clip connected to the A wire, press the Test button and monitor the LEDs.

Multiple wire cables

So far this article has referred to just testing a pair of wires, such as those in a telephone cable or Local Area Network (LAN) cabling. However, the tester can be used to test cables with multiple wires even if they are not paired.

The simplest way is to select one of the wires as a common A wire and then progress through the other wires as a second B wire. If you are working on cable that has, for example three pairs, you might construct a multiple diode lead with three diodes and six leads so that you could check all the pairs at one time.

Some cabling systems use a special socket to terminate a multiple pair cable. An example of this is an RJ45 socket used in modern building cabling where four pairs provide computer and telephone connections at one socket. A plug could be adapted to hold four diodes and plugged into the remote socket while the tester could be plugged into a mating socket at the local end.

A switch would need to be incorporated in the tester leads to select the pair to be tested. Finally the tester can be used as a general continuity tester to test diodes, speakers, audio/video cables, etc. The tester will indicate a short circuit with about 2kΩ or less placed across the test leads but this will vary from unit to unit and is dependent mainly on the characteristics of the ICs used. **SC**

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Cat. PS-4120 **ONLY $7.95**

50Ω RG-58 C/U NETWORK CABLE

At last, its now available from Jaycar. The special RG58C/U cable that is used in computer networking. Cat. WB-2012

NEW

$1.20/m or $85/100m Roll

NOW OPEN - NEW QLD STORE - ASPLEY 1322 Gympie Rd, Cnr Albany Creek Rd.

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

JAYCAR ELECTRONICS

AM/FM POCKET RADIO

See 97 Cat. page 180 for full details. Limted quantity. Cat. AR-2220

Was $17.95 Save $5

Nov. $12.95

6 WAY POWER OUTLET WITH MAINS FILTER AND TELEPHONE LINE PROTECTION

See 97 Cat. page 87 for full details. Cat. MS-4035

Only $44.95

UNIVERSAL CAR PHONE MOUNT

This phone mount is made in Taiwan for the American market. It is not an 'el cheapo' Chinese piece of crap! Fits any mobile phone and its easy to install. Spring loaded padded jaws hold the phone securely. Flexible mounting arm connects to the seat bolt without drilling, or to the floor/console with the base plate (needs drilling). Mounting platform slides/locks into place without screws & it tilts 180 degrees and swivels 360 degrees by adjusting wing nuts. Cat. YT-6120

NEW

Retail Price $59.95

Jaycar Price $29.95

GRIPMATIC CD MOUNT

Another surplus stock purchase!! Mount your portable CD in your car. Gripmatic positions your CD player firmly at your finger tips for easy access without hindering use of the passenger seat. Features include •Spring loaded padded jaws to hold CD player firmly in place without fastener tapes •Holds players up to 130mm wide •Anti-vibration suspension reduces skipping •Quick release mounting platform slides/locks into place without screws •Tilts 180° and swivels 360° by adjusting wing nuts •Mounting arm connects to seat bolt without drilling, or to floor base or console with base plate provided. Made in Taiwan! Cat. AR-1770

NEW

Retail Price $69.95

Jaycar Price $39.95

12-14" MONITOR ANTI GLARE FILTER

Limited quantity. Cat. XC-5150

HALF PRICE

Was $19.95

Now $9.95

SPIRAL BINDING

KEEP WIRING TIDY! Are you sick of messy cabling behind your Hi Fi video or computer or TV? Spiral binding is available in 2 sizes, and is easily wrapped around buches of cables to keep them tidy. Colour is black.

NEW

6MM DIA 2.5 METRE Cat. HP-1220 **$4.95**

12MM DIA 1.5 METRE Cat. HP-1222 **$4.95**

SUPER LARGE GREEN DISPLAY

Number is 57mm high (2.3") and housing is 70H x 43W. Common anode. See 97 Cat. page 154 for details. Cat. ZD-1852

Was $8.95

Nov $6.50

Save $2.45

THE UNTANGLER!

If the curly cord lead on your phone is always tangled, you need this product! It simply plugs into the handpiece, and rotates keeping the curly cord untangled. Made in USA. A quality product. Cat. YT-6075

NEW

$9.95

10 MEMORY THINPHONE

Pulse/tone switchable, last number redial. Easy call compatible. Can be wall mounted. White. Cat. YT-7050

Was $39.95 Save $5 Nov $34.95

NULL MODEM CABLE

D25M to D25F. 2 mtrs. Cat. PL-0858

Was $14.95

Save $5

Now $9.95

GUY WIRE KIT

Support your TV antenna pole. See 97 Cat. page 166. Limited quantity. Cat. LT-3250

Was $45 Save $10

Now $35

2N3055 TRANSISTOR

The old favourite! TO3, NPN, 115W, 100V. Cat. ZT-2300

Was $2.25

Nov Only $1.50

Save 75c

DOUBLE TV SOCKET

Limited quantity. White. Pal sockets. Cat. LT-3024

Was $3.95

Now $2

IDC CABLE SELLOUT

Limited quanty available. Not at dealers.

34 WAY Cat. WM-4506

Was $3.95mt.

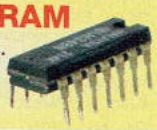
Now $1.50mt.

40 WAY Cat. WM-4507

Was $4.75mt. Now $2.50mt.

41256 DYNAMIC RAM

Limited quantity available. 120ns. Cat. ZZ-8435



Was $3.95

Now $1.95

ELECTRONIC SUBWOOFER CROSSOVER

Putting this in line (low level) with a standard car amplifier will give you an adjustable low frequency output for your sub woofer. Features Include: •Adjustable level control. •Gold plated RCA input/outputs. •Noise suppression inductor built in. •Size 65(W) x 90(D) x 27(H)mm.

NEW

Cat. AA-0475 **Only $29.95**

2 WAY ELECTRONIC CROSSOVER

Brand new model. We've found this crossover gives absolutely no noise (even with amp 8 crossover gains at max.) and with bass boost on. The crossover did not clip before the source signal. Features: •Remote power terminal block •LED power indicator •Output level controls •Bass boost on/off switch •Mono/stereo switch.•Gold plated RCA in/out socket •Heavy duty metal case (will be grey in colour). Cat. AA-0450

NEW

Only $89.95

NEW KEYSWITCHES

WE'VE MADE A SURPLUS DEAL OF 2 KEYSWITCHES.

NEW

SPST KEYSWITCH

This is a standard type key-switch, with 2 tubular keys supplied. 19mm mounting hole. Key removeable from both positions. Cat. SM-1033

Only $6.95ea

SPRING RETURN KEYSWITCH

NEW

The best way to describe this switch is to say its like a car ignition switch. Turn the key to the right, and it spring returns. Contacts are single pole, with both N/O and N/C available, and can be used simultaneously. Cat. SM-1034

Only $8.95ea

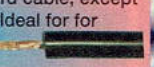
SUPER FLAT SPEAKER CABLE

Size is 11 x 2 x 11mm. Ideal for under carpet. Not available at dealers. Limited quantity available. Cat. WB-1738

Was $4.95 metre Nov. $2.95 metre

SINGLE SCREENED AUDIO CABLE

This is the same as our WB-1500 standard cable, except that the OD is 4.6mm instead of 2.6mm. Ideal for for longer runs. Cat. WB-1520



Was $1.70m or $116/100m

Now 50c metre or $40.00/100m Roll.

WORLD TIME CALCULATOR WATCH

1/2 PRICE

Features •12 Cities plus 1 free zone •Time •Alarm •Calculator. Cat. XC-0270

Was $12.95

Now $6.50

BULK USERS CONTACT OUR WHOLESALE DEPARTMENT FOR SPECIAL PRICING (02) 743 5222

BUY 10 LESS 10%

JAYCAR ELECTRONICS

NEW MAINS PRODUCTS

SINGLE ARCHITRAVE SWITCH
Cat. PS-4050
$7.25

SIDE ENTRY 240V PLUG
Cat. PP-4001
$2.95

SINGLE WALL SWITCH
Cat. PS-4055
$7.95

DOUBLE WALL SWITCH
Cat. PS-4057
$12.95

DOUBLE ARCHITRAVE SWITCH
Cat. PS-4052
$11.95

DOUBLE POWER POINT
Cat. PS-4060 **$16.90**

WALL PLATE MOUNTING BLOCK
Cat. PS-4062 **$4.50**

FLAT DOUBLE ADAPTORS
RIGHT Cat. PP-4035
LEFT Cat. PP-4036
$2.95ea

GLOBE BATTEN HOLDER
Cat. PS-4070 **$6.95**

LIGHT DIMMERS
With small plate and switch Cat. PS-4082
$16.95
With large plate and switch Cat. PS-4084
$16.95

EXTENSION CORDS
3.5m Long Cat. PS-4125
$5.95
5.5M LONG Cat. PS-4130 **$7.95**

DIMMER ONLY
Ideal for mounting in a standard switch plate Cat. PS-4080 **$10.95**

SWITCH POWER STATION
Each socket is individually switched, and there is an inbuilt circuit breaker.
Cat. MS-4050
$39.90

6 WAY SLIMLINE POWER BOARD
Cat. MS-4045
$13.95

CORDLINE SWITCH
Inline cord switch for 2 and 3 core cable up to 10A. Switches both active and neutral wires. Suitable for AC mains only.
Cat. PS-4075
$11.50

LARGE JUNCTION BOX
Cat. PS-4065
$5.95

150 WATT SWITCHMODE POWER SUPPLY DEAL
Another surplus bargain. These are removed from new equipment. Input is 240V or 110V via an IEC socket. Outputs are via 9 pin launcher headers. There is even a 2 way launcher for a cooling fan. Output voltages are: •3 x +5 volts @ 10 amps total •1 x +12 volts @ 2.5 amps total •1 x -12 volts @ 1.5 amps total •1 x +24 volts @ 160mA total. Supplied with performance spec. Board size 287(L) x 126(W)mm. Limited quantity available.
Cat. MP-3045
Was $39.95 Now $29.95

2 CHANNEL DP REMOTE CONTROL SWITCH - LATCHING & MOMENTARY
NEW
Now available, a 2 channel version of our remote control switch. Selectable between latching and momentary. Supplied with one transmitter. Extras are available, and are DIP switch coded.

2 CHANNEL
With one transmitter.
Cat. LR-8826
$79.95
Extra transmitters
Cat. LR-8827
$19.95ea

1 CHANNEL
With one transmitter.
Cat. LR-8828
$59.95
Extra transmitters
Cat. LR-8829
$17.95ea

NEW COMPUTER LEADS
NEW

SCSI-1 DB25M TO CENT 50M
Length 1mtr.
Cat. PL-0951 **$12.95**

SCSI-2 HALF PITCH 50M TO DB25M
Length 1mtr.
Cat. PL-0954 **$29.95**

SCSI-2 HALF PITCH 50M TO CENT 50M
Length 1mtr.
Cat. PL-0952 **$32.95**

SCSI-2 HALF PITCH 50M EACH END
Length 1mtr.
Cat. PL-0953 **$34.95**

SCSI-3 HALF PITCH 50M TO 68M
Length 1mtr.
Cat. PL-0955 **$49.95**

SCSI-3 HALF PITCH 68M EACH END
Length 1mtr.
Cat. PL-0956 **$59.95**

SCSI-3 HALF PITCH 68M TO CENT 50M
Length 1mtr.
Cat. PL-0957 **$44.95**

SCSI-3 CENT 50M TO CENT 50M
Thick cable. Length 60cm.
Cat. PL-0958 **$19.95**

GENDER CHANGER CENT 50F TO CENT 50F
Centronics 50 pin female either side.
Cat. PA-0945 **$16.95**

NEW GENERATION RF WIRELESS HEADPHONES
Infrared cordless headphones are better than wired ones. These new RF headphones allow you to use them with complete freedom all around your house - up to 30 metres away. Jaycars' direct importing saves big $$ over others' selling prices. Headphones includes a volume control for each ear. Includes mains adaptor to run from 240V. 2 x AAA batteries required. Energiser batteries $4.95 Pair Cat. SB-2380.
Specifications: •RF TX frequency 40.68mHz •Frequency response 50Hz to 18,000Hz •S/N ratio >50dB(A) •Transmit distance 30 mtrs.
MONO Cat. AA-2003 **$69.95 PR**
STEREO Cat. AA-2004 **$99.95 PR**

SAVE 30% ON CAR POWER CABLE
The current stock we have is not quite up to full 4G and 8G specs. Its slightly smaller, but will still do the job perfectly in 99% of installations. Your chance to save !!

8GA POWER CABLE
Normally $2.95 mt. / $220 100mt. roll.
Now $1.95 mt. / $170 100 mt. roll.
RED Cat. WH-3060
BLACK Cat. WH-3062

4GA POWER CABLE
Normally $7.95 mt. / $325 50mt. roll.
Now $5.50 mt. / $225 50 mt. roll.
RED Cat. WH-3064
BLACK Cat. WH-3066

GOLD INLINE FUSEHOLDERS
Features an "O" ring to keep moisture out. Total length 112mm. Accepts 5AG fuses. 40A rated.
8AG Cat. SZ-2066
4AGCat. SZ-2068
Were $9.95 each
Nov. $6.95 each
SAVE $3

VIDEO PROCESSOR WITH ENHANCER & STEREO MIXER
Limited quantity. See 97 Cat page 170 for full details.
Cat. AV-6410
Was $79.95
Save $20
Now $59.95

UHF/VHF SEPARATOR
Allows you to mix together, or separate a VHF and UHF signal. Limited quantity. Not at dealers.
Cat. LT-3028 *Was $5.95*
Now $2.95

MICROPHONE MIXER
Connects 3 mics to the one input. No power required.
See 97 Cat. P169. Cat. AM-4210
Was $22.95 Save $7
Now $15.95

CAT 5 RJ45/45 LEADS

		WAS	NOW	SAVE
1M	Cat. PL-0770	$8.50	$5.50	$3.00
3M	Cat. PL-0772	$12.95	$8.95	$4.00
5M	Cat. PL-0773	$16.95	$11.95	$5.00

UNIVERSAL CROSSOVER PC BOARDS

NEW

BUILD YOUR OWN CROSSOVERS

These brand new 2 and 3 way crossover printed circuit boards have been designed as a versatile method of building your own customised crossover that will suit just about any speaker system. They can be used on 4 or 8 ohm speakers, and even with a combination of both. They can be wired to give a max. of 12dB per octave, or by leaving some components out, they could be 6dB or a combination of both. Full instructions on how to select the various components for different crossover frequencies are included, as well as an attenuation table for tweeters. Inductors & capacitors are available from Jaycar see 97 Cat P47 2 WAY Size: 122x122mm. 3 WAY Size: 140x195mm.

2 WAY PC BOARD
Cat. CX-2605 **$11.95 ea**

3 WAY PC BOARD
Cat. CX-2606 **$14.95 ea**

OK SOLDER STATION

Buy in November at $199 and receive free 1Kg. roll of solder worth $24.95. Cat. NS-3002

Buy This Cat. TS-1620 **Get This Free**

Cat. NS-3002

Only $199

SAVE ON "MINI WAVE" TIPS

Tips for soldering SMTdevices by hand. They have a hollow section in the centre to hold solder. Not available at Dealers at these prices. Limited quantities.

TIPS FOR OK SA442	Cat. TS-1640
TIPS FOR HAKKO 926	Cat. TS-1642
TIPS FOR WELLER WTCP	Cat. TS-1644

Were $17.95ea. **Now $12.95ea.**

COMPUTER LEAD

D9 female to D25 male.
Cat. PL-0870

Normally $9.95

Save $2.00

Nov. $7.95

LARGE TAMPER RESIST TORX SCREWDRIVERS

T25 size Cat. TD-2066 and T27 size. Cat. TD-2068

Normally $9.95ea
Save $3.00
Nov. $6.95

LED BARGRAPHS

10 Red LEDS
Cat. ZD-1700
Was $5.50 **Nov. $3.95**

10 Red LEDS
Cat. ZD-1704
Was $4.95
Nov. $2.95

7 Green, 3 Red LEDS Cat. ZD-1706
Was $5.95 **Nov. $3.95**

MINI TOWER CASE

Includes 200W PSU. See 97 Cat. P161 for details.

Cat. XC-4635
Was $89.95
Nov. $74.95

TV HEADPHONES WITH VOLUME CONTROL

NEW

Lightweight headphones especially suited to watching TV, and not disturbing others around you. Has inline volume control for left and right speaker, and long 5 mt. cord. Supplied with 3.5mm stereo plug & adaptor to 3.5mm mono plug. Freq range 20Hz - 20kHz; Impedance 32 Ω; Sensitivity 96dB at 1kHz; Max input power 100mw
Cat. AA-2005

$9.95

BATTERY CHARGER SENSATION

For November, buy our 8 x AA Fast Charger - At the catalogue price of $39.95 and receive free 8 x 800mA Nicads (Cat. SB-2450) worth $28.00!!

Buy This Cat. MB-3510 **Get These Free**

Only $39.95

240V TO 115V AC STEPDOWN TRANSFORMERS

Allows you to operate American appliances on our mains power. Autotransformer construction. See 97 Cat. page 86 for full details.

250 WATT
Cat. MF-1094
Cat. Price $89.95
Nov. $79.95
Save $10

500 WATT
Cat. MF-1096
Cat. Price $119
Nov. $109
Save $10

LASER POINTERS

Cat. ST-3100 **$39**

KEYRING SAVE
Cat. ST-3102 **$45**

CAR BATTERY DISCHARGE PROTECTOR

Cuts out when the car battery voltage goes below 11.2V, so you don't get a flat battery. Connects inline with item used, via cigarette lighter plug. Max. current 10A. Very limited quantity available. Not available at Dealers. Cat. AA-3095

Was $27.95 **Now $20**

CAR CELLULAR PHONE ANTENNA

Sellout. Save over normal prices. Not available at Dealers. See 97 Cat. page 62 for details.
Cat. DC-4040

Was $39.95 Save $9.95
Now $30

MOTORBIKE ALARM

Remote control. remote start, engine kill, silent arming plus more. See 97 Cat. page 74 for details.
Cat. LA-8915

Save $80
Was $179.50
Nov. $99.50

CLAMP SETS

For details see 97 Cat. P106.

HOBBY F CLAMP SET	HOBBY G CLAMP SET
Set of 3.	Set of 3.
Cat. TH-1960	Cat. TH-1962
Normally $7.95	Normally $5.95

Nov. Buy Both For $10

EARPHONES WITH VOLUME CONTROL

NEW

These earphones incorporate an anti-sound leak design and have a separate volume control for left & right speaker. Ideal for portable CD players, Hi Fi's, portable stereos, or other audio equipment. Using a 3.5mm stereo socket. Includes 2 free earpads. Frequency range 12Hz - 20kHz; Impedance 32Ω; Max input power 40mW; Cord length 1.2 mts; Plug 3.5mm gold stereo.

Cat. AA-2017 **$6.95**

400 AMP CAR BATTERY CLIPS

The largest clips! Ideal for 300W and 500W invertors. Length 155mm. Sold in a pair 1 Red / 1 Black.
Cat. HM-3085

Was $9.95 pr
Nov. $6.95 pr
Save $3

"RODE " MIC CABLE

4 core hi-quality mic cable. Sellout price. Limited quantity. Not available from Dealers.
Cat. WB-1528

Was $2.95 metre
Nov. $2 metre

POCKET SHIFTER MULTITOOL

Includes •Shifter with 18mm jaw opening •Phillips head screw driver •Slotted screwdriver •File •Canopener •Bottle opener •Knife •Supplied with holder and belt clip •Made in Taiwan.

Cat. TH-1905 ***Was $19.95*** ***NOW HALF PRICE***

November $10

JAYCAR ELECTRONICS

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

SOUND/LUGGAGE/SAFETY BELT

Another surplus stock purchase! This is a really nice quality neoprene carry belt. It's designed for a Walkman but is ideal as a safety pouch, like you see all the tourists wearing. It has one main compartment (size about 115W x 50D x 130H approx.) There is a very small compartment which could hold a cigarette lighter, keys or folded notes, and two others which are designed to hold AA batteries, etc. The belt is adjustable, and the oversized flap on the big compartment keeps out rain.

NEW

Cat. AR-1790

Retail Price $24.95

Jaycar Price $9.95

"HEARTFIT" HEART RATE MONITOR

Observe your hearts performance while you exercise. See 97 Cat. page 178 for full details. Cat. QM-7240

Was $99.95 **Now $79.95** Save $20

SINGLE F59 TV SOCKET

Accepts F59 plug both sides of socket.

Cat. LT-3042 Was $2.95 **Now $1.50**

SOUNDVISOR CD ORGANISER

NEW

Soundvisor is an easy way to organise compact disks in your car. Simply attach soundvisor with its elastic straps to your car's sunvisor. Ultra soft cotton pockets firmly hold and protect 6 CD's. There is also 2 pen holders, a mesh pouch for sunglasses and zippered map compartment are included for added convenience. Just flip down your visor to retrieve or replace a CD. Flip it up and put CD's out of sight. Fits all car visors.

Size 313(L) x 150(H)mm. Cat. AR-1780

Retail Price $19.95

At Jaycar Only $14.95

OPEN AN ACCOUNT WITH JAYCAR

NEW JAYCAR FAN

12V DC 120 x120 x 25mm. Specs. Air volume 80cfm Noise 42dB Speed 3000rpm. Ball bearing. Cat. YX-2518

NEW **$27.50**

STICK ON TIME

Large digits, adjustable stick on swivel base. Cat. XC-0225

Was $9.95 **Now $6.95** Save $3

64K DATA STORAGE SELLOUT!!!

See 96 Cat. page 170 for full details. Not available at dealers. Cat. QM-7320

Was $129.50 **Now $50**

46 available.

DIGITAL TYRE PRESSURE GUAGE

Measures in PSI. Cat. QM-7235

Cat. Price $19.95

Nov. $15.95

Save $4

MOTORCYCLE INTERCOM

Uninterrupted 2 way communication between rider and pillion passenger. See 97 Cat. page 177. Limited quantity. Not available at dealers. Cat. AI-5510 Was $29.95

Now $24.95 Save $5

BACK IN STOCK COMPUTER MICROPHONE

Designed for multi-media use. See 97 Cat. page 160 for full details. Cat. AA-2028

Only $19.95

MICROTAC HANDS FREE KIT

Plugs into bottom of phone and cigarette lighter. Includes plug-in earpiece for private conversation if required. Cat. YT-6105

Cat. Price $69.95

Nov. $49.95

Save $20

Save Big $$$$

COMPUTER LEAD SPECIAL

CENTRONICS PLUG TO CENTRONICS - PLUG (36 PIN) 2.0M. LONG. Cat. PL-0872

Was $19.95 **Now $12.95** Save $7

BOOKS - BOOKS - BOOKS

50 SIMPLE LED CIRCUITS VOL 2

Limited quantity. 57 pages. Cat. BB-7014

Was $5.95 Save $2

Nov. $3.95

25 AMATEUR RADIO ANTENNAS

How to build 25 simple and inexpensive Amateur Band antennas. 63 pages. Limited quantity.

Cat. BB-7019 *Was $5.95* *Save $2*

Now ONLY $3.95

BEGINNERS GUIDE TO ELECTRONIC COMPONENTS

Explains resistors, pots, capacitors, diodes, transistors, ICs, speakers, microphones, etc. 166 pages. Limited quantity.

Cat. BB-7002 Was $11.50 Save $4

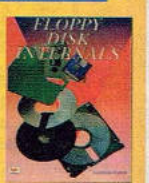
Nov. $7.50

EASY PC INTERFACING

Explains how to get those unused ports back to work. See 97 Cat. page 188 for details. Cat. BB-7051

Only $15.95

FLOPPY DISC INTERNALS



Whats inside a disk and controller cards. 107 pages. Cat. BM-2492

Was $16.95 Save $4.95

Nov. $12

AUDIO & VIDEO SYSTEMS BOOK

Learn about microphones, speakers, recording, Hi Fis, preamps, acoustics, theatre sound, digital recording and more. 223 pages. Cat. BM-2496

Was $17.95 Save $5

Nov. $12.95

WIRELESS DOORBELL SALE

Limited quantity. See 97 Cat. page 177 for details.

TRANSMITTER AND RECEIVER Cat. AI-5520

Was $24.95 Save $5

Now $19.95

EXTRA RECEIVER Cat.AI-5525

Was $19.95 Save $4

Now $15.95

5 PIN DIN TO DIN LEAD

Stock up

Standard lead as used to connect cassette decks etc. Cat. WA-1000

Normally $4.95

Now $2

FREECALL FOR PHONE ORDERS 1800 022 888

TURN YOUR SURPLUS STOCK INTO CASH!

Jaycar buys surplus/distress stock of most electronic products from components to built products.

If you have marketable quantities of stock you need to clear contact us on

Ph: 02 9743 5222 Fax: 02 9743 2066

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

MAXELL GOLD RECORDABLE CD'S

Best price in town? 74min, 680mB. Cat. XC-4710

Only $5.99
10+ $5.39

PCB MOUNT MINI TOGGLE

C & K brand

7103. SPDT Centre off, horizontal lever action, long activator (23mm). Cat. ST-0564

Were $1 each
Nov. 50c. or 10 for $4.00

HANDS FREE TELEPHONE HEADSET

These are a quality headset and microphone ideally suited for office situations where other people may be distracted by the two way conversation, or could be used on two way radios in vehicles. See 97 Cat. page 52 for full details. Cat. AA-2018

Was $23.95
Save $9
Nov $14.95

Commander / PABX Phone Extension Leads

These have 6 wires instead of the usual 4.

3 metres Cat. YT-6016 **Was $15.95**
Now $9.95 **Save $6**

10 metres Cat. YT-6018 **Was $18.95**
Now $11.95 **Save $7**

15 metres Cat. YT-6019 **Was $22.95**
Now $14.95 **Save $8**

IC BARGAINS

	Was	Nov.	Cat.
4019 CMOS	$1.50	10 for $6	ZC-4019
4012	$0.80	10 for $2	ZC-4012
4015	$1.45	10 for $2.50	ZC-4015
4024 CMOS	$1.00	10 for $2	ZC-4024
4068 CMOS	$1.00	10 for $3	ZC-4068
74LS109	$1.25	10 for $2	ZS-5109
74LS175	$1.65	10 for $3	ZS-5175

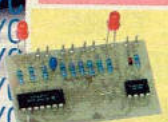
UP-TO-DATE WORLD'S TRANSISTOR, DIODE, THYRISTOR & IC'S COMPARISON TABLES SELLOUT

See 97 Cat. page 190 for full details.

VOLUME 1 (ONLY 55 AVAILABLE) **BM-2480**
WAS $24.95 **NOW $20**

VOLUME 2 (ONLY 108 AVAILABLE) **BM-2482**
WAS $24.95 **NOW $18**

LOW COST MIDI BREAKOUT BOX KIT



See 97 Cat. page 10. Limited quantity. Cat. KA-1756

Was $13.95 **Save 3.95**
Sellout $10

OUR CANBERRA STORE HAS MOVED

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JV40 Vifa speaker kit	28pr	CS-2570	489.00pr	300pr
JV40 Cabinets	17pr	CS-2572	239.00pr	150pr
JV80 8" Woofer M22	46	CW-2115	199.50ea	120ea
JV80 8" Cabinet	36	CS-2540	139.00ea	69ea
JV110 10" Woofer M26	37	CS-2118	229.50ea	140ea
JV110 Cabinet less Baffle	23	CS-2552	149.00ea	90ea
JV110 Baffle	9	CS-2256	30.00ea	19ea
8" Black cone woofer	90	CW-2111	27.95ea	18ea
10" 8Ω Re/Sponse woofer	37	CW-2143	169.50ea	109.50ea
Pot plant speaker	32	CE-2305	99.00ea	69ea
Rock speaker	87	CE-2300	99.00ea	69.00ea
Vifa D25shielded tweeter	113	CT-2022	59.50ea	39.50ea
M13SG 5" shielded woofer	128	CW-2103	89.50ea	59.50ea

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As required to increase current capacity of KC-5225 10A DC speed control kit Cat. ZR-1030

$5.95

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NEW

REFER EA NOV. 97.
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NEW

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NEW

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DOOR RELEASE TO SUIT $34.95 Cat. QC-3415

Cat. QC-3410 **Only $469**

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See June ad for full details. Be quick, very small quantities available.

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Now $350	Now $695

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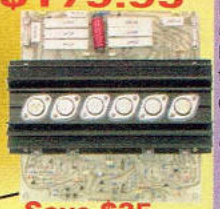
REFER: EA JUNE 1980. They're back! Thousands in service around Australia. Great for bands, PA or Hi Fi.



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Includes •50W lamp - 51mm dia. •Downlight holder (white) •Mains transformer, power lead

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Due to supply problems, we have found a new supplier of our cutters and pliers. Our new suppliers offer better quality tools.

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1-9 Only 75c
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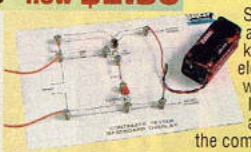
Ideal for kids!



LEARN ELECTRONICS

Short Circuits assumes they know nothing about electronics. The book shows you what electronic components look like and how they work. There are 21 projects to build and all the components are supplied to build all the projects. There is no soldering required and all components are mounted on a baseboard with springs. Some projects are:
•Short circuit tester •Police siren •Sound effects •Light chaser •Solar powered radio •Amplfier •Buzzboard & more.

SHORT CIRCUIT BOOK & PROJECT KIT *Used In Schools

NEW KIT FROM JAYCAR

HEAVY DUTY 10A 240VAC MOTOR SPEED CONTROL KIT

NEW

REFER: SILICON CHIP NOVEMBER, 1997
Using switchmode power supply techniques, this is an outstanding controller that will give you smooth control from zero to full speed. Use it to control drills, lawn edgers, routers, circular saws and other appliances with brush type motors. Kit includes dust proof case, PCB, silk-screened front panel all specified electronic components.

Cat. KC-5235 **$119.00**

500W POWER AMPLIFIER MODULE KIT

REFER: SILICON CHIP AUG, SEPT, OCT 97
Kit includes PCB plus all electronic components. Transformer MT-2190 $169.00, pre-tapped heatsinks (2 required) HH-8555 $42.50 all available separately. **10,000uF CAPACITORS.** Note that the ripple current rating of our capacitors is 8.1A. Some suppliers have only 5.0A capacitors. Normally $39.95 ea. Buy the 8 together for only $35.95 ea, saving $32 Cat. RU-6712.

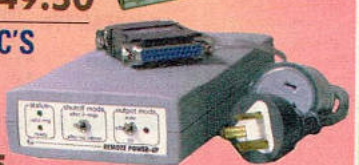
Cat. KC-5231 **$219.00**

TV COLOUR PATTERN GENERATOR KIT

REFER: SILICON CHIP JUNE JULY, 1997
Generate colour bars and patterns or customise your own using low cost software available from the magazine. Supplied with PCB, pre-programmed EPROM, case, panels and all components.

Cat. KC-5224 **$149.50**

REMOTE POWER UP KIT FOR PC'S



REFER: EA JUNE, 1997
Switch your PC and other appliances over the phone line. Case, PCB and components included.

Cat. KA-1794 **$49.95**

RF SHIELDED PHONE CASES

WHY TAKE THE RISK? We're not sure whether the stories you hear are true or not. Some people it seems, appear to get headaches from continual mobile phone use. Jaycar has sourced a range of genuine leather mobile 'phone cases to suit most popular models. So what? Well these cases have a special lead - yes lead - insert sewn into the lining of the leather case. This lead runs right across the earpiece (where your head is closest to the 'phone) and right around the base of the antenna where RF radiation is generally the greatest. If you are worried about the potential hazard from mobile 'phone radiation why not try one? At $29.95 it costs no more than a standard quality leather case anyway.

HALF PRICE

Microtac	Cat. HC-6920
Motorola 8200,8400	Cat. HC-6922
Motorola Flare	Cat. HC-6924
Motorola 8500,8700	Cat. HC-6926
Nokia 2110	Cat. HC-6930
Nokia 1610	Cat. HC-6932
Nokia 8110	Cat. HC-6934
Nokia 3110	Cat. HC-6936
Ericsson 318/388	Cat. HC-6938
Ericsson 738/788	Cat. HC-6940

Lead shield shown opened. Shield is simply wrapped around the antenna base.

Were $39.95 ea
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1/2 PRICE
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Cat. HB-6038 Was $12.95
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#2 INSTRUMENT CASE WITH ALUMINIUM FRONT/REAR PANELS
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Cat. HB-5982 Was $14.95
Now $9.95 Save $5

#3 INSTRUMENT CASE WITH ALUMINIUM FRONT & REAR PANELS
260(L) x 180(W) x 65(H)mm
Cat. HB-5984
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"K" TYPE THERMOCOUPLE BARGAIN

Our suppliers sent us a shipment of these DMM temperature thermocouples without probe. Cat. QM-1283 Grab a spare **Normally $12.95 (with probe)**

THESE AREONLY $5EA ONLY 200 AVAIL.

DOLBY PRO LOGIC SURROUND SOUND DECODER & EFFECTS UNIT KIT

See Cat. page 4 for details

DOLBY SURROUND PRO • LOGIC

KC-5200 **Was $379**

Nov. $299 **Save $80**

VIFA 2 WAY CROSSOVERS

Another surplus stock purchase. These have been designed for some old style Vifa kits. The SAX50 suited a 5" Vifa woofer and a D19 tweeter, & the SAX70 suited a Vifa 8" paper cone and D19 tweeter. The crossovers are mounted on a nice rear terminal which we sell for $5.25 alone. Both handle about 40 WRMS. Supplied with freq graph & schematic diagram. Limited quantity available.

NEW

SAVE ABOUT $25

SAX50 CROSSOVER FREQUENCY 3 KHZ Cat. CX-2609

SAX70 CROSSOVER FREQUENCY 4 KHZ Cat. CX-2608

Only $14.95ea

MAKE YOUR HOME LOOK ALARMED FOR $40

Most home burglar alarms have a siren and flashing strobe mounted in a metal box on the verandah, or under the front eaves. Burglars casing the street easily know who has an alarm, and who doesn't. Now you can make your home look alarmed with our new kit for a very low price.

SIREN COVER	**$29.95**
STROBE	**$19.95**
3 ALARM STICKERS	**$ 6.00**
NORMALLY	**$55.90**

Cat. LA-5130 Was $49

November $40 **Save $9**

"FULL HOUSE" POWER DRIVER BIT SET

All the weirdo driver bits in one go!! -The set consists of 32, of the driver bits that you don't normally see. You don't get any slotted, Phillips or Posidrive bits. You do get: •4 x Tri - wing, size 1, 2, 3, and 4 •9 x Torx (tamperproof), size T8, T10, T15, T20, T25, T27, T30 and T35 •4 x Pin drive (snake), size 4, 6, 8 and10 •6 x In - Hex (allen), *metric, size 2, 2.5, 3, 4, 5 and 6 •6 x In - Hex (allen), *imperial size 5/64", 3/32", 7/64", 1/8", 9/64" and 5/32" •3 x Torque Set, size 8, 9 and 10. With this you get a hex driver with magnetic retainer, all in a nifty plastic - rubber holder that is smaller than a deck of cards! (67 x 45 x 30mm). you will never get stopped by a wacko screw ever again!! SAVE $10

Cat. TD-2035 **Now Only $19.95**

MULTIMETER CASE

Made from black vinyl, and lined inside. It has 2 compartments. 175 x 95 to hold the multimeter and 175 x 23 for the leads. Divider can be removed. Cat. QM-1365

Save $3.95

Was $8.95 ***Nov. $5***

BUY 10 LESS 10%

SCOOP PURCHASE OF THE DECADE AURA INTERACTOR

Plug it into computer games, stereos etc, then put the back pack on and feel all the low frequency sounds. See previous ads for full details. Cat. XC-1000

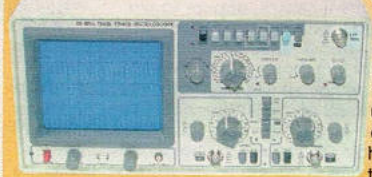
SAVE $210!

WAS $249

THEN $49.95

NOVEMBER $39.95

25 MHZ DUAL TRACE CRO



Brand new model with 5" screen and suited to a wide range of applications. Features include a deflection coefficient of 5mv/div to 20V/div in 12 calibrated steps. It also gives algebraic ADD, SUBTRACT, INVERT & X-Y modes. The time base range is from 0.5µsec/div to 0.2 sec/div in 18 calibrated steps. A continously variable uncalibrated control between the steps, along with X5 expansion extends the fastest sweep speed to 40nS/div approx. Variable hold/off, in addition to multimode triggering, provides versatile triggering up to 40Mhz.

SUPPLIED WITH 2 PROBES. Cat. QC-1900 NEW **$699**

8MM CAMCORDER CLEANING KIT

Camcorder heads need to be kept clean. You can look after your valuable camera with this kit. Consists of: •Head clean tape • Head cleaning fluid •Lens cleaning fluid •Blower brush •50 sheets lintless cleaning sheets. Distress stock purchase. Normal retail price is around $24.95.

Cat. AR-1420

Was $9.95

November Only $5.00

TURN YOUR SURPLUS STOCK INTO CASH! Jaycar buys surplus/distress stock of most electronic products from components to built products. If you have marketable quantities of stock you need to clear contact Bruce Routley or Mark Ostro on Phone: 02 9743 5222 Fax: 02 9743 2066

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By RICK WALTERS

Regulated Supply For Darkroom Lamps

Don't let variations in the mains supply ruin your photographic prints. This regulated power supply will keep the halogen lamp in your enlarger at its correct colour temperature.

Maintaining an enlarger lamp at its correct colour temperature is important when doing darkroom work, especially if you expect to obtain consistent results. In particular, the colour temperature of the lamp is critical for colour prints, although you can often get away with small variations for black and white prints.

Unfortunately, many a darkroom session can be made frustrating by small variations in the lamp output due in turn to variations in the mains supply. These variations are quite normal and can be due, for example, to heaters or air-conditioners cycling on and off or to some other cause.

When this occurs, the lamp output changes and this affects both its colour temperature and exposure times. To overcome this problem, some readers have asked us to design a mains stabiliser but these are expensive and impractical for the hobbyist to construct.

This Halogen Lamp Supply will effectively do the same job at a fraction of the cost. It provides a well-regulated 12V supply for the halogen lamp in the enlarger and varies its output by just 2mV for mains input voltages ranging from 195VAC to 280VAC.

The unit is also very easy to operate. The front panel carries just a mains rocker switch, a power indicator LED and a toggle switch to turn the lamp on and off. Alternatively, the enlarger lamp can be turned on and off via a remote switch connected to a terminal block on the rear panel.

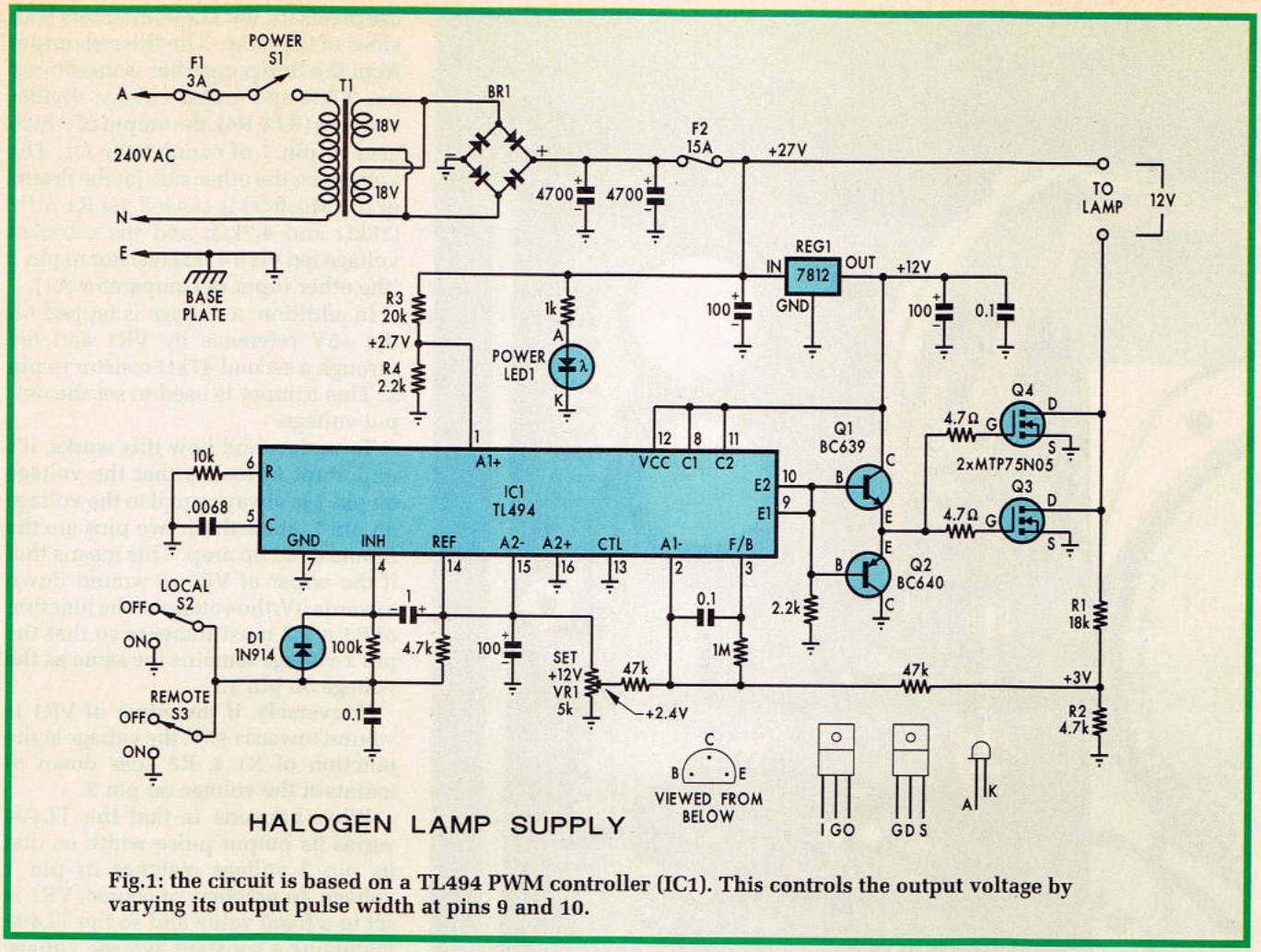


Fig.1: the circuit is based on a TL494 PWM controller (IC1). This controls the output voltage by varying its output pulse width at pins 9 and 10.

The circuit (see Fig.1) is basically a regulated 12V power supply capable of supplying up to 10A. It uses a mains transformer to feed a full-wave bridge rectifier and this then supplies an unregulated filtered DC voltage to a switching regulator circuit.

In this type of regulator, the output switching devices (power Mosfes) are either on or off and so their losses are quite low. In fact, the bridge rectifier gets much hotter than the output devices.

Circuit details

Let's now take a look at the circuit in greater detail. As shown in Fig.1, the primary of the transformer is protected by a 3A slow-blow fuse which has been specified to handle the high inrush current.

The two 18V secondary windings of the transformer are connected in parallel to provide the required current and these feed the bridge rectifier. This in turn supplies the rectified DC to two 4700µF filter capacitors which are both needed to cope with the high ripple current. They are followed by a 15A fuse which is only included to provide output short circuit protection.

The output of the fuse is fed directly to one side of the lamp and to REG1, a 12V regulator which supplies a stable voltage to the rest of the circuit. We could probably have omitted the regulator as IC1 has its own inbuilt reference but as we are looking for a rock steady output, we decided to include it.

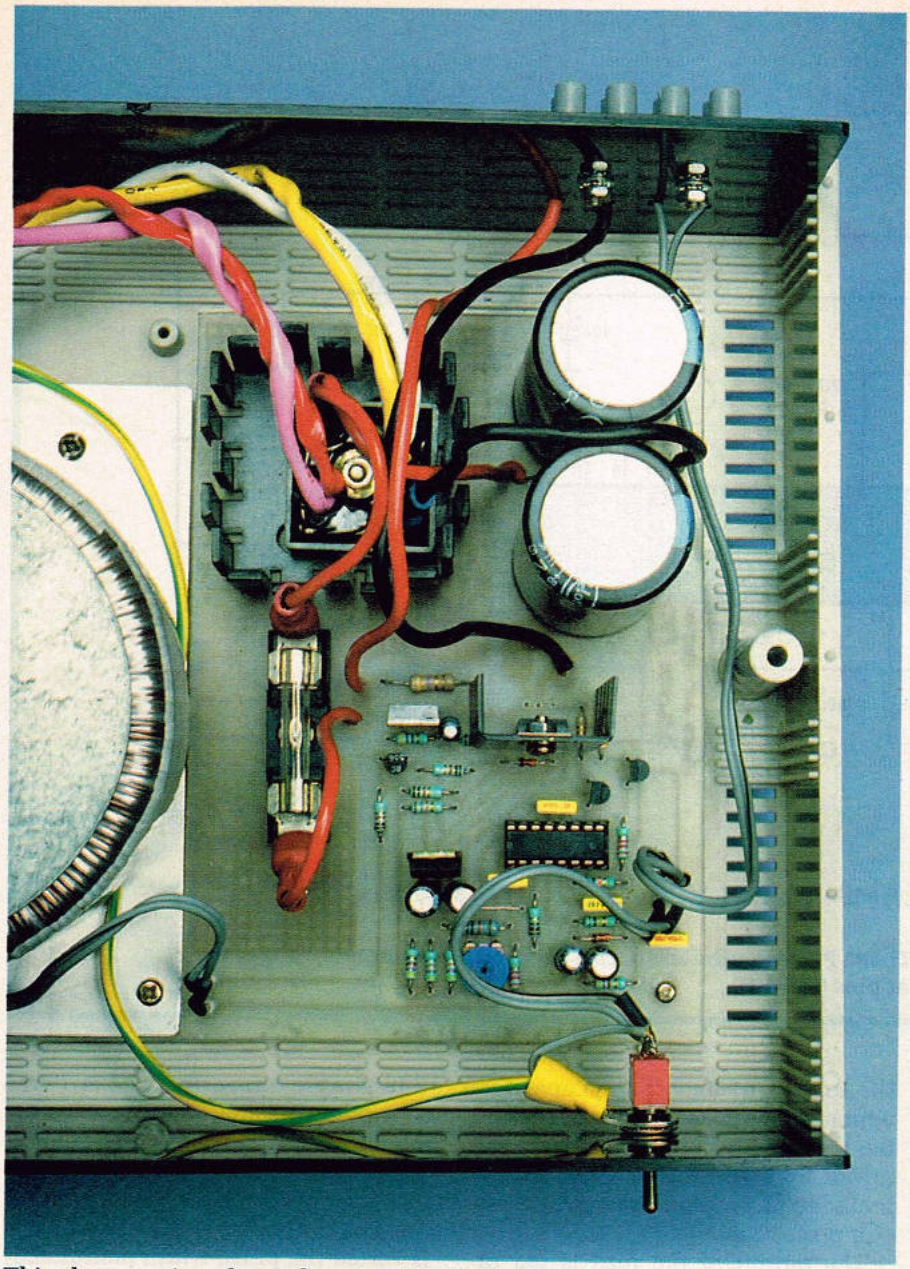
The heart of the circuit is IC1, a TL494 pulse width modulation (PWM) controller. Inside this device is an onboard oscillator, a reference regulator, two error amplifiers, several comparators and a pair of output driver transistors. You can find out more about this device by referring to the Motor Speed Controller article in the June 1997 issue (a block diagram of the device was published on page 28).

In simple terms, the TL494 PWM controller operates as follows. Its oscillator runs at 20kHz (as set by the RC components on pins 5 & 6) and it produces a pulse train at its outputs at this frequency. The width of the pulses is varied (ie, pulse width modulated) and the ratio of the "on" time to the "off" time controls the voltage applied to the load which in this case is the enlarger lamp.

A fraction of the output voltage is fed to one input of one of the error amplifiers (pin 2 of A1), while the other input (pin 1) is connected to a reference voltage. If the output voltage rises slightly, the error amplifier senses this change and alters the output on-off ratio to bring the output voltage back to the required level.

This is done by reducing the "on" time at the device outputs (pins 9 & 10). The converse applies for a falling output voltage.

Pins 9 & 10 of IC1 are simply the emitters of the two output transistors,



This close-up view shows the assembled PC board with one Mosfet fitted. Note that the board was modified after this photo was taken and some parts shown here have been deleted from the final design.

connected here in parallel. Their collectors at pins 8 & 11 are connected to a +12V supply rail derived from 3-terminal regulator REG1. This means that the internal transistors operate as emitter followers and each time they turn on, they pull the bases of Q1 & Q2 to +12V.

As a result, the emitters of Q1 & Q2 which are wired as complementary emitter followers, together with the gates of Q3 & Q4, swing from 0V to +12V. This means that the gate drive signal is limited to this voltage.

Q1 and Q2 are included for another reason and that is to rapidly charge and discharge the gate capacitances of the Mosfets each time they turn on and off. This improves the switching action of the Mosfets; ie, it speeds up their turn-on and turn-off times and thereby reduces their power dissipation.

Each time the Mosfets turn on (ie, when Q1 & Q2 turn on), current flows through them and the lamp to ground. The switching regulator (IC1) then acts to ensure that the average output voltage applied to the lamp is 12V.

In order to control the output voltage precisely, the TL494 monitors both sides of the lamp. The filtered output from the bridge rectifier is monitored via 20kΩ and 2.2kΩ voltage divider resistors (R3 & R4), the output of which goes to pin 1 of comparator A1. The voltage on the other side (at the drains of the Mosfets) is sensed via R1 & R2 (18kΩ and 4.7kΩ) and the sampled voltage fed via a 47kΩ resistor to pin 2 (the other input of comparator A1).

In addition, a voltage is tapped off the +5V reference by VR1 and fed through a second 47kΩ resistor to pin 2. This trimpot is used to set the output voltage.

To understand how this works, it's important to realise that the voltage on pin 2 is always equal to the voltage on pin 1, since these two pins are the inputs of an op amp. This means that if the wiper of VR1 is wound down towards 0V, the voltage at the junction of R1 & R2 must increase so that the pin 2 voltage remains the same as the voltage on pin 1.

Conversely, if the wiper of VR1 is wound towards +5V, the voltage at the junction of R1 & R2 goes down to maintain the voltage on pin 2.

What happens is that the TL494 varies its output pulse width so that its pin 2 voltage matches its pin 1 voltage. In practice, of course, VR1 is set to a fixed value and so the TL494 maintains a constant average voltage on the drains of the Mosfets and thus across the lamp.

Note that the reference voltage for pin 1 of IC1 has been derived from the unregulated DC supply rail. This has been done so that the circuit automatically compensates for mains voltage variations. If the mains voltage varies, then so does the unregulated DC supply rail and thus the voltage on pin 1. As a result, the TL494 varies its output pulse width to bring the pin 2 voltage into line and keep the average lamp voltage constant.

Slow start circuit

Switches S2 (local) and S3 (remote) are used to turn the lamp on or off. They work in conjunction with a slow start circuit which has been included to prolong the life of the lamp.

If both switches are off, the 1µF capacitor between pins 4 & 14 of IC1 will be discharged due to the 4.7kΩ resistor and diode D1. The voltage on the inhibit pin (pin 4) will thus be equal to the REF voltage on pin 14

(5V) and there will be no output from the TL494.

Conversely, when one of the switches is closed, the 1µF capacitor charges via the 100kΩ resistor in parallel with D1. During this time, the voltage on the inhibit pin gradually falls and the output pulse width from the TL494 steadily increases. This means that the lamp voltage rises steadily to 12V, thereby providing a soft start.

Construction

Most of the parts are accommodated on a PC board coded 10107971 and measuring 145 x 102mm. Before commencing the assembly, check the board carefully against the published pattern to ensure that there are no etching defects.

Fig.2 shows where all the parts go. No particular order need be followed when assembling the board but it's best to start with the smaller parts first (resistors, trimpot, diodes and low-value capacitors). Table 1 shows the resistor colour codes but it's also a good idea to check the resistor values on a digital multimeter.

Take care to ensure that the correct transistor is installed at each location and that its orientation is correct. We used an IC socket for the TL494 but this can be considered optional. It too must be correctly orientated, as must D1 and the electrolytic capacitors.

PC stakes are used for the external connections to the local and remote switches and to LED1. Do not use PC stakes for the other wiring connections though – these points carry heavy currents and the leads should be soldered directly to the PC board.

Although the circuit diagram (Fig.1) shows two Mosfets in parallel, one should be sufficient for lamp loads up to about 5A (ie, for lamps rated up to 60W). This Mosfet can be mounted in either the Q3 or Q4 position and should be fitted with a small U-shaped heatsink (see photo of prototype). If the lamp is rated at more than 60W, then the second Mosfet should also be installed.

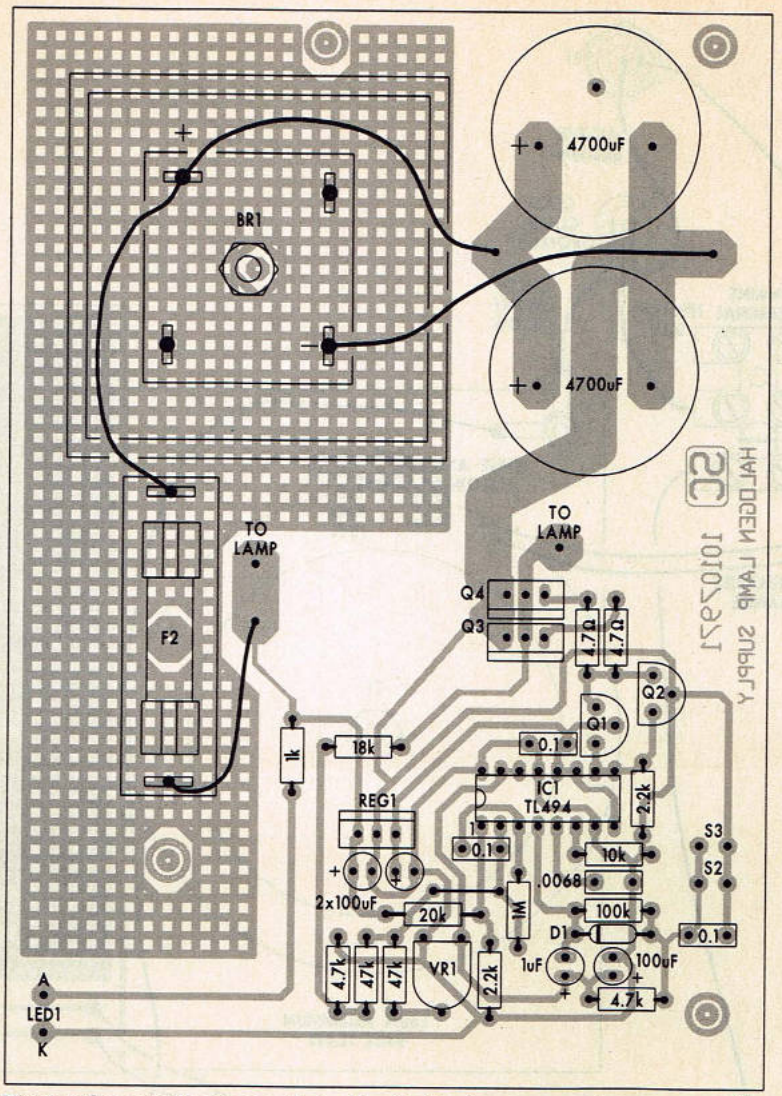


Fig.2: take care to ensure that all polarised components are correctly orientated when building the PC board. You can use just one Mosfet for lamp loads up to about 60W.

Note that it will be necessary to splay the fins on one of the heatsinks slightly, so that the second heatsink can be fitted to its Mosfet. Make sure that the metal tabs of the Mosfets go towards IC1. The metal tab of REG1

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	20kΩ	red black orange brown	red black black red brown
❑	1	18kΩ	brown grey orange brown	brown grey black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	2	4.7Ω	yellow violet gold brown	yellow violet black silver brown

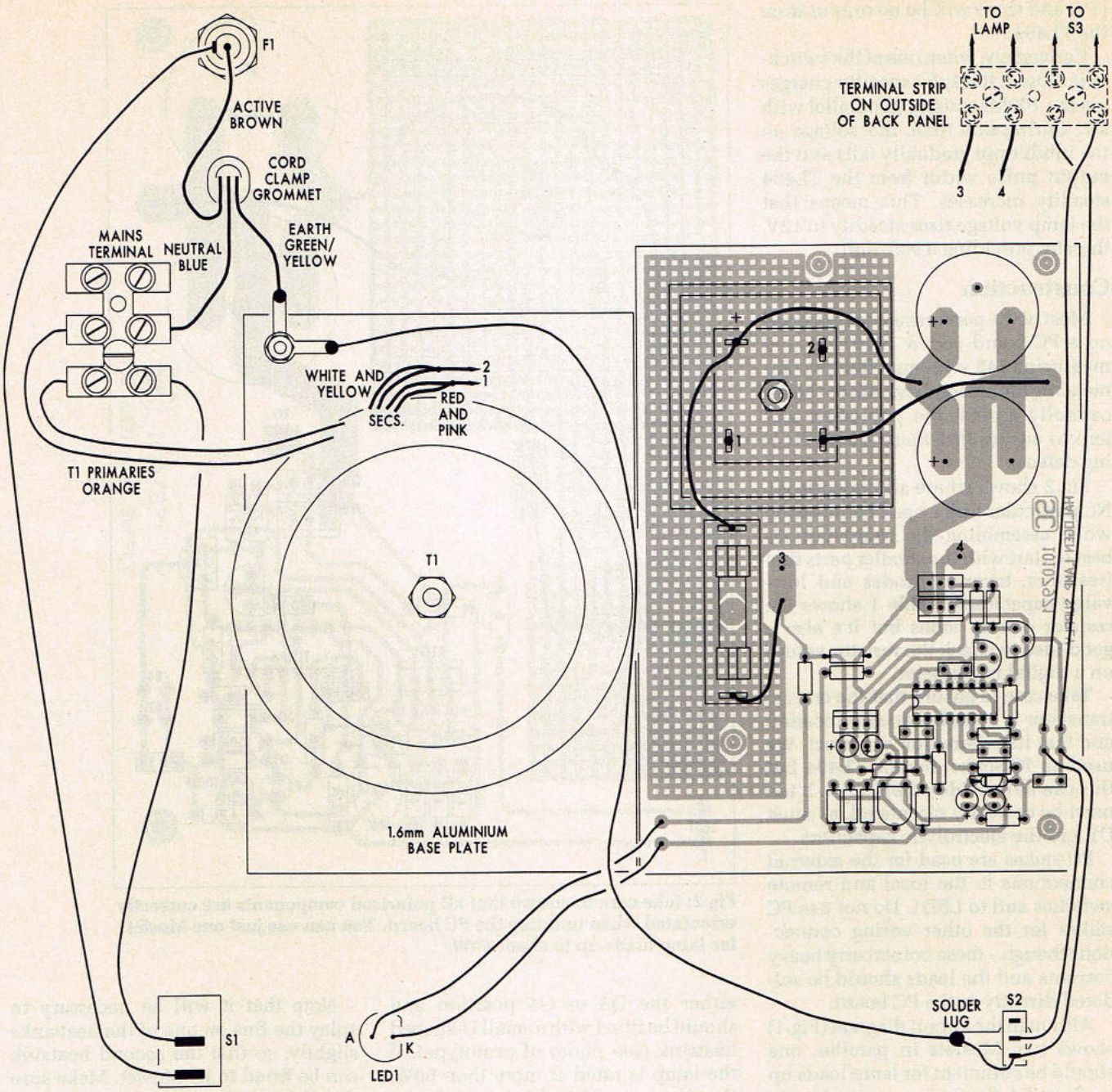


Fig.3: be sure to use mains-rated cable for all wiring to fuse F1, the mains terminal block, switch S1 and for the earth connection to S2. LED1 and the wiring to it can be omitted if you use a neon-illuminated mains rocker switch.

faces in the opposite direction.

Now install the two large 4700µF electrolytic capacitors and fit the bridge rectifier and the chassis-mount fuseholder. These last two items are bolted to the PC board using machine screws and nuts. Orient the bridge rectifier so that its "+" and "-" terminals are located as shown and note that a Powerfin heatsink (normally drilled for a TO-3 transistor) goes between it and the PC board.

Smear heatsink compound over the bottom of the bridge rectifier before bolting it down. You can use one of the existing TO-3 mounting holes, which means that the bridge rectifier will sit slightly off-centre.

The PC board assembly can now be completed by installing the wiring to the fuseholder and to the "+" and "-" terminals of the bridge rectifier (BR1). Use heavy duty 10A cable for this job. We used automotive-style spade connectors to terminate the leads on the bridge rectifier and fuseholder terminals.

Two more heavy-duty cables, each about 180mm long, should also be soldered to points 3 and 4 on the PC board. Use a red lead for the point 3 connection and a black lead to point 4 (these are the output leads for the lamp and are later run to a terminal block mounted on the rear panel).

Drilling the case

A standard plastic instrument case with plastic front and rear panels is used to house the circuitry. Fig.3

shows the layout inside the case. As can be seen, the power transformer (T1) is mounted on an aluminium baseplate and this is secured, along with the PC board, to integral standoffs on the base of the case using self-tapping screws.

The first step is to mark out and drill the necessary holes in the baseplate. You will need four mounting holes for the case standoffs, a mounting hole in the rear lefthand corner to secure the earth solder lugs, and a mounting hole in the centre to take the power transformer bolt.

The hole locations for the standoffs can be easily marked out by first marking the tops of the standoffs with a felt pen and then carefully pressing the aluminium plate onto them. This done, the holes can all be centre punched and drilled to 3mm.

By the way, the aluminium baseplate allows the mains wiring and the circuit to be correctly earthed. As such, it is an important safety measure and must not be deleted.

When drilling is complete, deburr all the holes and secure the two earth solder lugs in position using a machine screw, washer and nut. An additional locknut should then be fitted so that the earth lugs can not come loose. This done, secure the transformer to the baseplate, then fasten the baseplate to the case standoffs using four self-tapping screws.

Note that the transformer is secured using a large bolt, two rubber washers and a large metal washer. One of the rubber washers sits under the transformer, while the second sits under the metal washer at the top.

The front and rear panels can now be drilled to accept the various hardware items. The front panel requires a rectangular cutout for the mains switch (S1), plus holes for the power indicator LED and toggle switch S2. If you use a mains switch with a neon illuminated rocker, the power indicator LED can be omitted.

The cutout for the mains switch can be made by drilling a series of small holes around the inside edge of the cutout area and then knocking out the centre piece. The edges should then be cleaned up using a file and the cutout carefully enlarged until the mains switch just fits. Make sure that the switch is a tight fit and that it cannot accidentally fall out.

Moving now to the rear panel, you will require mounting holes for the cordgrip grommet, the fuseholder and the 4-way terminal strip. The locations of these components can be gauged from the photographs and from Fig.3. Note that the mains cord hole should be carefully profiled to match the cordgrip grommet.

Parts List

1 PC board, code 10107971, 145 x 102mm
1 160VA toroidal power transformer with two 18V secondaries; Jaycar MT-2113, Altronics M4055 or equivalent
1 plastic case, 200 x 160 x 70mm
1 panel-mount 3AG fuseholder
1 3A 3AG fuse (F1)
1 chassis-mount 3AG fuseholder; Altronics Cat. S6010 or equiv.
1 15A 3AG fuse (F2)
1 3-way mains terminal block
1 4-way mains terminal block
1 mains switch with plastic rocker; Jaycar Cat. SK-0984 or SK-0985 (illuminated)
1 mains lead with moulded 3-pin plug
1 miniature toggle switch
1 Powerfin heatsink (DSE Cat. H-3400 or equiv).
1 semi-mini heatsink (DSE Cat. H-3404 or equiv).
3 solder lugs
1 piece of aluminium, 130 x 90 x 1.6mm
1 5kΩ horizontal PC-mount trimpot (VR1)

Semiconductors
1 TL494CN switching regulator controller (IC1)
1 BC639 NPN power transistor (Q1)
1 BC640 PNP power transistor (Q2)
1 or 2 MTP75N05 Mosfets (Q3,Q4) – see text
1 7812 regulator (REG1)
1 1N914 small signal diode (D1)
1 400V 25A bridge rectifier (BR1)
1 red LED and mounting bezel (LED1) (not needed if mains switch has neon-illuminated rocker)

Capacitors
2 4700µF 25WV PC electrolytic
3 100µF 25WV PC electrolytic
1 1µF 16VW PC electrolytic
3 0.1µF MKT polyester
1 .0068µF MKT polyester

Resistors (0.25W, 1%)

1 1MΩ	1 10kΩ
1 100kΩ	2 4.7kΩ
2 47kΩ	2 2.2kΩ
1 20kΩ	1 1kΩ
1 18kΩ	2 4.7Ω

Miscellaneous
Heatshrink tubing, red and black heavy-duty hookup wire, light-duty figure-8 cable, mains-rated cable (brown, blue & green/yellow)

Final wiring

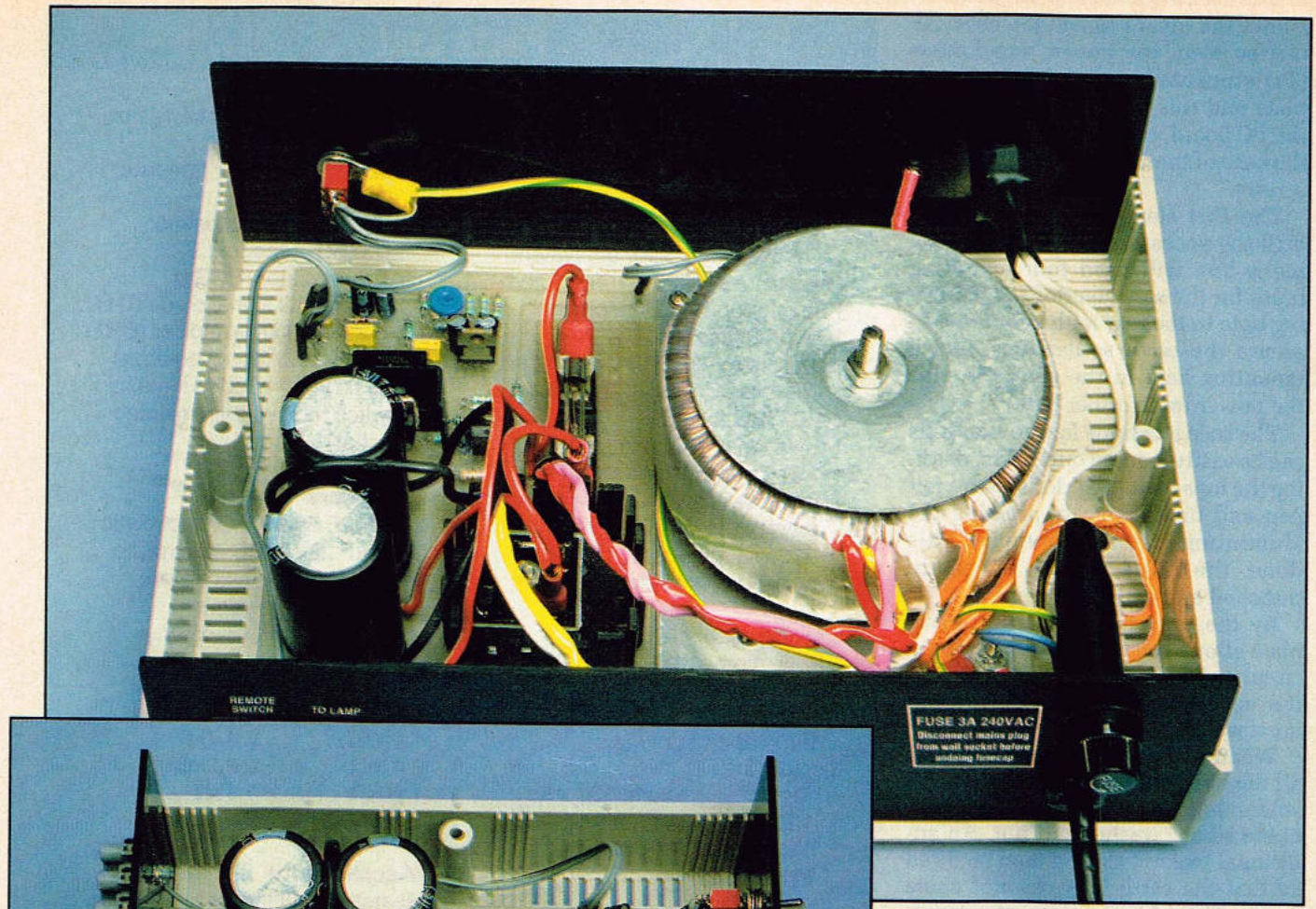
The hardware items can now all be mounted in the case, ready for wiring – see Fig.3. Note that the mains terminal strip is secured to one of the case standoffs using a self-tapping screw.

Exercise extreme care when installing the mains wiring, as your safety depends on it. In particular, make sure that the mains cord is securely anchored by the cordgrip grommet on the rear panel and cannot be pulled out.

The Active (brown) lead from the mains cord goes directly to fuse F1, the Neutral (Blue) lead goes to the mains terminal block, and the Earth lead is soldered to one of the earth lugs on the baseplate. Additional mains-rated leads are then run from the fuse and terminal block to the mains switch (S1).

The terminals of the fuseholder and mains switch should be covered with heatshrink tubing to prevent accidental contact with the mains. This involves slipping a length of heatshrink tubing over all the leads before they are soldered to the terminals. After soldering, the heatshrink tubing is pushed over the fuseholder and mains switch bodies and shrunk using a hot-air gun.

The two orange wires from the transformer are the primary leads and these go to the mains terminal block, as shown. The low-voltage secondary



The power transformer is mounted on an aluminium plate which must be securely earthed. Sleeve all exposed terminals on the mains switch and fuse with heatshrink tubing to prevent accidental contact with the mains.

leads are much thicker. Twist the red and pink leads together and terminate their ends in a spade terminal. This done, do the same for the white and yellow leads, then connect the transformer secondaries to the AC terminals on the bridge rectifier.

Finally, complete the wiring to LED 1, switch S2 and to the rear-panel terminal strip. Note that a solder lug goes over S2's collar and that an earth lead (mains rated) is run from this collar back to an earth solder lug on the baseplate. This earths the metal parts of the switch body, including the toggle actuator.

Testing

Before switching on, go back over the wiring carefully and check that all is correct. This done, wind VR1 fully clockwise apply power and check the

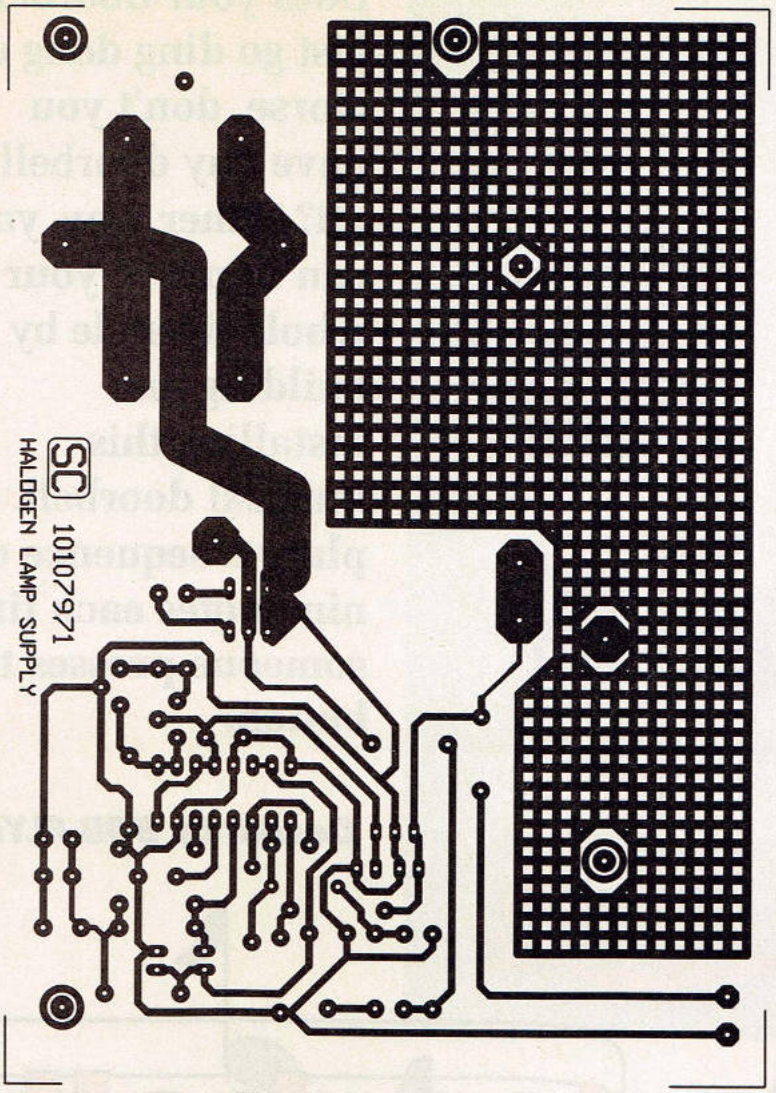


Fig.4: check your PC board against this full-size etching pattern before installing the parts.

REMOTE SWITCH	TO LAMP (12V)

FUSE 3A 240VAC
Disconnect mains plug from wall outlet before removing fuse

Fig.5 (above & right): these two labels can be affixed to the rear panel above the terminal block and next to the mains fuse.

voltages at various points on the circuit. You should get about +27V at the output of the bridge rectifier, +2.7V on pin 1 of IC1, +5V on pin 14 and +12V on pin 12 (ie, the output of REG1).

If all these voltages are correct, connect a 12V test lamp and a voltmeter across the output terminals and carefully wind VR1 up until you get 12V. You should now be able to measure about 2.4V at the wiper of VR1 and 3.0V at the junction of R1 and R2 although your unit may vary slightly from these figures.

Finally, the output voltage should be reset when the enlarger lamp is connected, to make sure it is correct.

That's it – you can now tackle your darkroom printing jobs without being affected by annoying variations in the lamp output. SC

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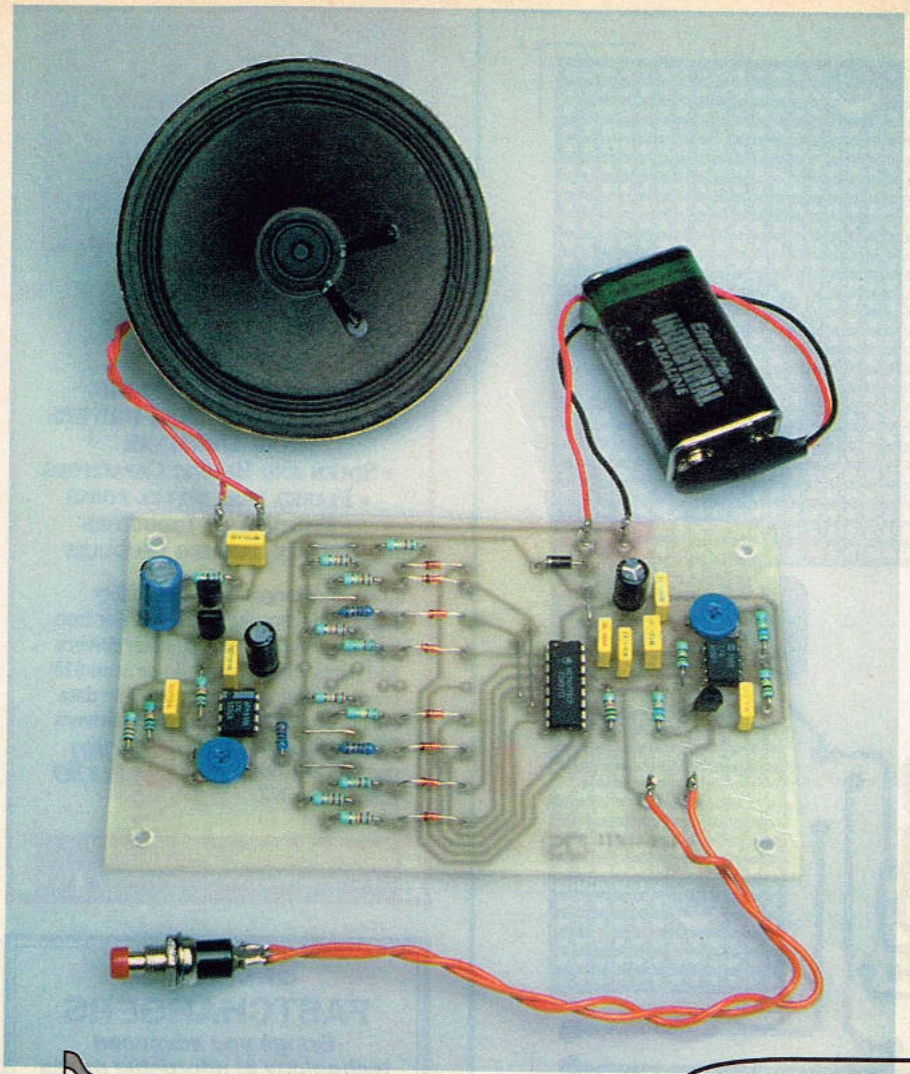


Does your doorbell just go ding dong or worse, don't you have any doorbell at all? Either way, you can improve your whole lifestyle by building and installing this musical doorbell. It plays a sequence of nine notes each time someone presses the button.

Design by BOB FLYNN

Musical Doorbell

ALRIGHT, WE'LL come clean. Maybe building this musical doorbell might not make a huge difference to your lifestyle but then again maybe it might. One of the visitors to your home might be so impressed by your unique doorbell that they might offer you a partnership in a huge new electronics venture. You never know . . .

The new doorbell uses just three cheap ICs and three transistors in the circuit. There are two good ol' reliable CMOS 555 timers, a 4017 counter and not much else. We are presenting this project just as a PC board, knowing that you will want to make your own arrangements as far as the case and loudspeaker are concerned.

The unit will play virtually any tune of up to nine notes although there is a proviso which we will come to later. Let's have a look at the circuit of Fig.1.

There are two separate 555 oscillators and a 4017 decade counter. What happens is that the first 555 oscillator (IC1) produces the clock pulses for counter IC2. IC2 then counts from 0 to 8 and then stops on the tenth clock pulse. The whole circuit waits until the next time the door bell button is pressed but we're getting a little ahead of ourselves.

Each output of the 4017 counter is used to produce a separate frequency from the second 555 timer, IC3. This then drives an amplifier stage consist-

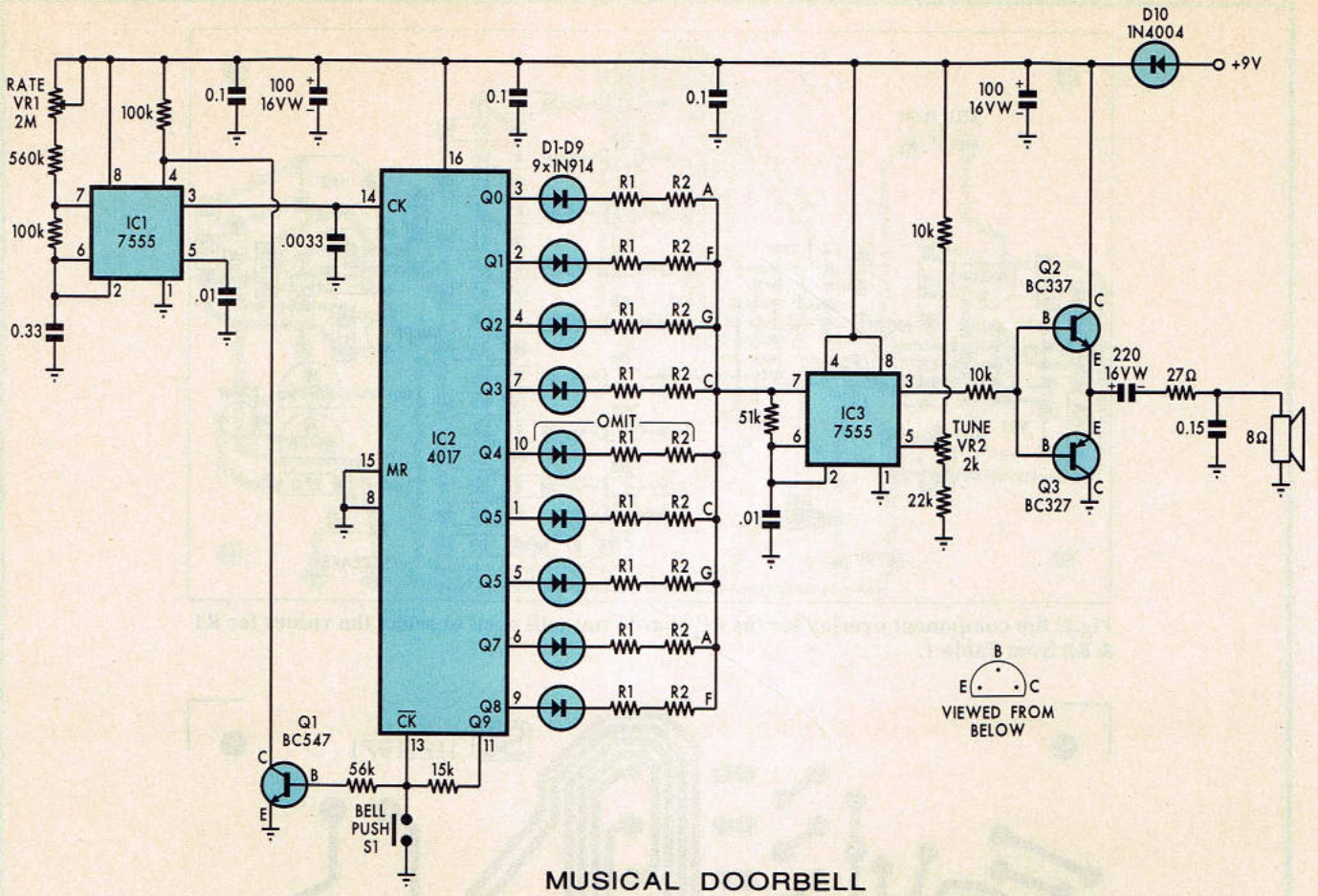


Fig.1: IC2 is the heart of the circuit and its nine outputs cause IC3 to produce nine different notes as it counts through.

ing of two transistors, Q2 & Q3, which drive the loudspeaker.

How it works

Now let's have a more detailed look at how the circuit works. IC1 is a conventional 555 timer circuit with its output frequency variable between about 1.3Hz and 5.5Hz, depending on the setting of the 2MΩ trimpot VR1.

The only unusual feature of the circuit of IC1 is the connection to pin 4. In normal free-running 555 oscillator circuits, pin 4 is tied to the positive supply rail but in this case we use pin 4 to start and stop oscillation.

The output pulses from pin 3 of IC1 are fed to the clock input of IC2 and each of its outputs from Q0-Q8 goes high in turn for the duration of a clock pulse. Each 4017 output is fed via a diode and two resistors (R1 & R2) to pin 7 of IC3. Depending on the values of R1 & R2 connected to each 4017 output, IC3 can then generate a different note in a nine-note sequence.

On the tenth clock pulse, the Q9 output of IC2 goes high and this pulls the clock enable pin 13 high and also pulls the base of transistor Q1 high. The combination of these two events effectively stops IC2 on the tenth count and ensures that when pushbutton S1 is pressed, the pin 3 output of IC1 immediately goes high to give a full first count in the nine count sequence from IC2.

IC3 generates the nine notes. The frequency of each note is determined by the sum of the resistance of resistors R1 & R2, the 51kΩ resistor between pins 6 & 7 and the .01μF capacitor at pins 2 & 6. Table 1 shows the values to provide one octave of notes including sharps and flats.

The overall pitch of all the notes can be shifted up or down by the tune control, trimpot VR2. This takes advantage of the fact that you can shift the upper and lower thresholds of the 555 timer with an adjustable voltage divider connected to pin 5.

The pin 3 output of IC3 drives a rudimentary amplifier stage consisting of complementary emitter followers Q2 & Q3. These in turn drive the 8Ω loudspeaker via a 220μF coupling capacitor and a 27Ω current limiting resistor.

Since the output waveform is essentially a pulse train, the complementary amplifier stage can operate in class-B and do without such niceties as quiescent current. By the way, the output from pin 3 of IC3 has a varying duty cycle, depending on the frequency, since the resistor between pins 6 & 7 is constant at 51kΩ while resistors R1 & R2 are varied.

Construction

As noted above, we are presenting this project just as a PC board, knowing that you will want to make your own arrangements as far as the case and loudspeaker are concerned. The PC board measures 129 x 79mm and is coded 11211971. Fig.2 shows the component overlay.

After checking the PC board for any etching defects or undrilled holes, in-

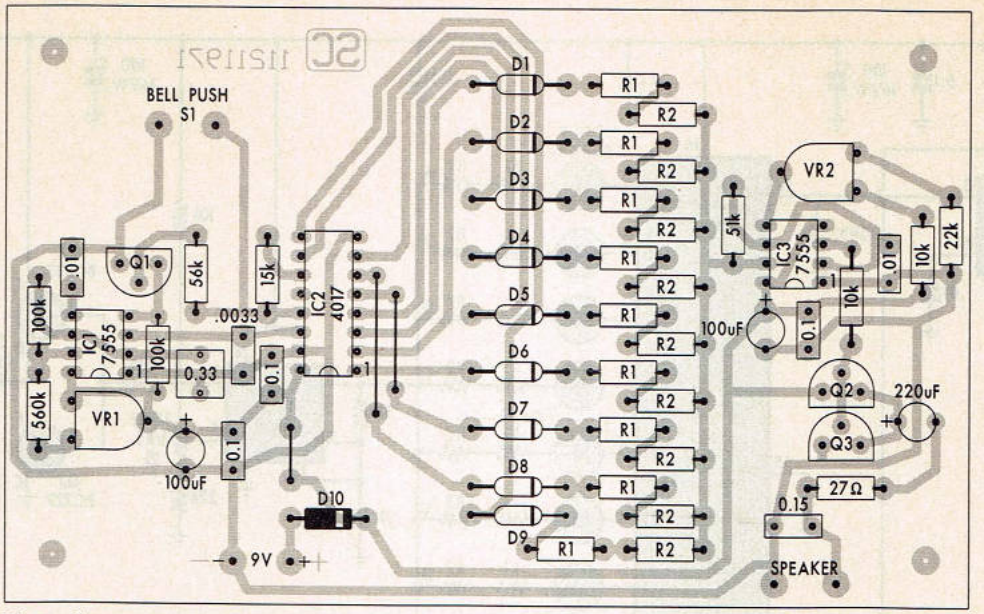


Fig.2: the component overlay for the PC board. You will need to select the values for R1 & R2 from Table 1.

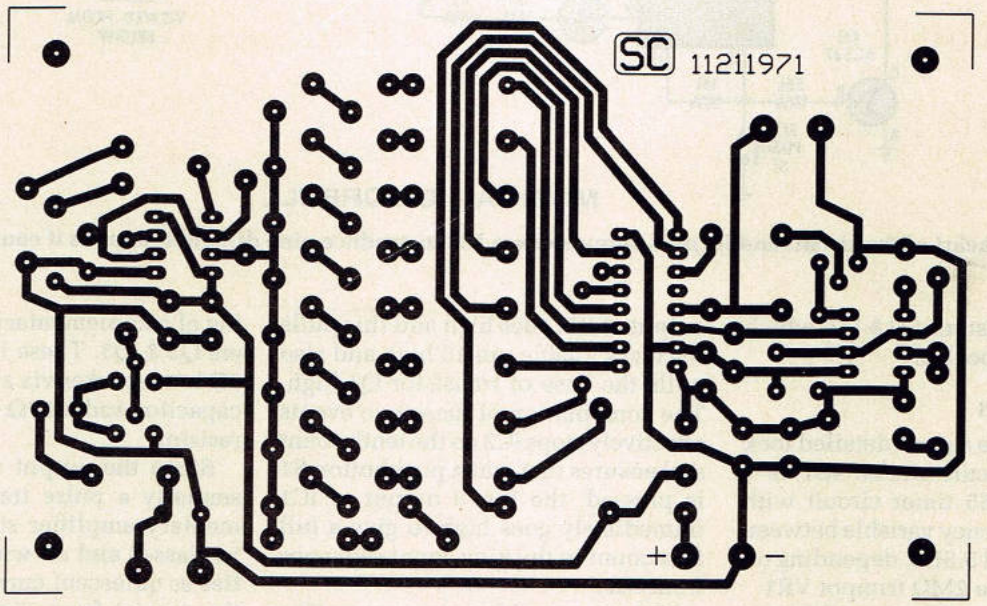


Fig.3: here is the full-size etching pattern for the PC board.

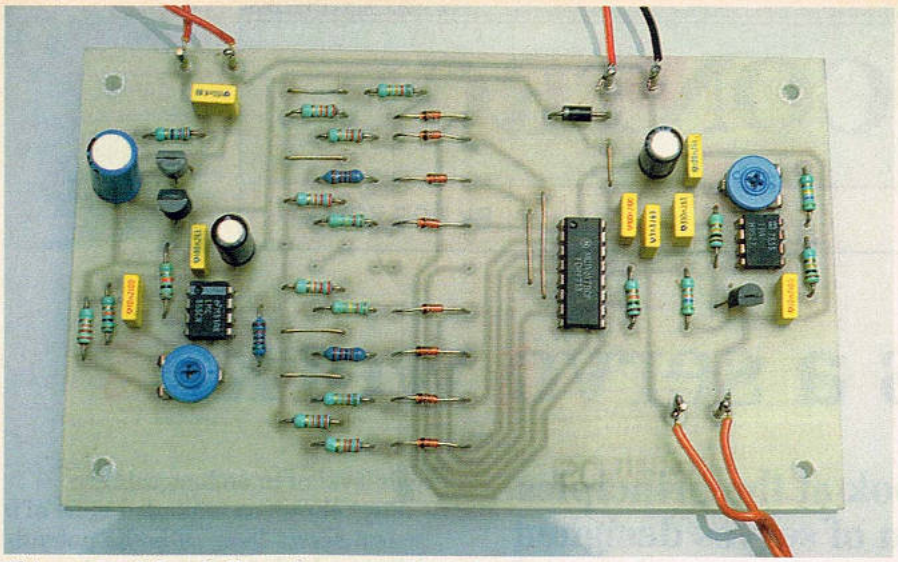
stall the PC stakes for the supply, loudspeaker and pushbutton connections. This done, install the wire links, the diode and the resistors. It is a good idea to check each resistor value with your multimeter before you install it.

Ah, now what values should you use for R1 & R2? Table 1 shows the values for various notes so if you have a favourite few bars of music you can determine the notes you want and pick the resistors accordingly. But there is one little drawback to be noted.

Since the 4017 counts from one to nine in a continuous sequence, the notes are produced in the same sequence, with no gaps in between. This does not present a problem if all adjacent notes in the sequence are different but if you have two adjacent notes which are the same you do have a problem. Instead of having two separate notes you will just get one long note.

The only way of overcoming this, short of adding extra gates to provide a short break between each note, is to leave a one-note gap between two identical notes. This means that your tune will be shortened to eight notes and you will then need to omit the diode and resistors R1 & R2 for that note position.

Going back the circuit of Fig.1 for a moment, that is why the diode and the resistors associated with the Q4



This musical doorbell can be arranged to play a nine-note sequence each time you press the pushbutton. Make sure that all parts are correctly oriented.

output of IC2 have the note "Omit". The circuit actually shows the note sequence for "Westminster Chimes" and since the fourth and fifth notes are both C, we've had to omit the resistors and diode for the Q4 output of IC2.

So this long-winded explanation makes the point: if you have a tune with two adjacent notes the same, you will need to leave gap (in time) otherwise you will get one note the same.

Table 1

FREQUENCY (Hz)	NOTE	R1	R2
523.2	C	120k	24k
554.3	C#	130k	LINK
587.3	D	110k	6.8k
622.2	D#	100k	4.7k
659.2	E	91k	1.8k
698.4	F	82k	LINK
739.9	F#	68k	3.6k
783.9	G	62k	LINK
830.5	G#	47k	5.6k
880	A	22k	22k
932.2	A#	33k	2.7k
987.7	B	27k	1k
1046.4	C'	18k	2.7k
1108.6	C#'	10k	3.9k
1174.5	D'	7.5k	LINK

The obvious alternative to this dilemma is to choose a tune which does not present this problem.

Having inserted all the resistors, you can now finish the board assembly, taking care to ensure that all the semiconductors and electrolytic capacitors are inserted the correct way around.

Testing

To test the finished board, you will need a 9V battery or DC power supply, an 8Ω loudspeaker and a pushbutton. If all your work is correct, the board should run through its sequence of notes as soon as the supply is connected and then fall silent. After that, nothing should happen until you push the button and then the note sequence should be produced.

If the circuit does not work as it should you can check the operation of each stage with your multimeter. For example, the output at pin 3 of IC1 should pulse up and down at around two or three times per second if trimpot VR1 is at its mid setting. You can check this with your multimeter set to read DC.

Similarly, you can check that each of the outputs of IC2 go high in turn and so on.

Options

You have several options for powering the circuit. First, you can use a 9V battery but ideally this should employ six C or D cells to obtain long battery life. If you use a 9V (Eveready 216 size), the battery will not last long.

Parts List

1 PC board, code 11211971, 129 x 79mm
6 PC stakes
1 momentary contact pushbutton switch (S1)
1 6V or 9V battery or DC plugpack (see text)
1 8Ω loudspeaker
1 2MΩ trimpot (VR1)
1 2kΩ trimpot (VR2)

Semiconductors
2 7555 timers (IC1, IC3)
1 4017 decade counter (IC2)
1 BC547 NPN transistor (Q1)
1 BC337 NPN transistor (Q2)
1 BC327 PNP transistor (Q3)
9 1N914, 1N4148 small signal diodes (D1-D9)
1 1N4004 silicon diode (D10)

Capacitors
1 220µF 16VW PC electrolytic
2 100µF 16VW PC electrolytic
1 0.33µF MKT polyester
1 0.15µF MKT polyester
3 0.1µF MKT polyester
2 .01µF MKT polyester
1 .0033 MKT polyester

Resistors (0.25W, 1%)
1 560kΩ
2 100kΩ
1 56kΩ
1 22kΩ
1 15kΩ
2 10kΩ
1 27Ω
Values for R1 & R2 depend on desired notes – see Table 1.

You could also use a 6V lantern battery but then the 27Ω resistor in series with the loudspeaker should be reduced to 18Ω.

Alternatively you could power the circuit with a 6V or 9V DC plugpack, bearing in mind that their operating voltage will typically be around 50% more; ie, 9V and 13V, respectively. Do not use a 12V DC plugpack because the output voltage will be too lightly loaded for this circuit. You would run the risk of blowing the chips as the plugpack voltage is likely to be as high as 17V.

Finally, if you do use a DC plugpack instead of a battery, you can save a little money by using ordinary 555s instead of 7555s. Their current drain will be a lot higher but that does not matter with a plugpack. **SC**

RADIO CONTROL

BY BOB YOUNG

How does a servo work?

This month we take a look at the principles underlying the operation of servos designed for use with R/C systems. You move the stick on your transmitter and the servo moves to a new position. Why? We shall find out.

Not only is the design of the typical R/C servo an elegant example of modern mass production but the system whereby six, seven or more channels of data are modulated onto the radio carrier is elegant as well.

It is here that the great mystery begins for the average electronics buff. Just what is the system of modulation and how does it result in such precise clockwise (CW) and counter-clockwise (CCW) control of an electric motor?

The basic servo is best defined as a closed loop, error cancelling system in which some of the output is fed back into the input in such a way that the system automatically seeks to come to rest in a state of zero error. In this null or neutral position it should draw negligible current. Fig.1 is the block diagram of such a system.

A typical modern R/C servo has the following components: a plastic housing and gear train, electric motor, feedback potentiometer and a servo amplifier. The feedback potentiometer is mechanically linked to the servo output arm either directly or indirectly via a gear train. The indirect drive servo minimises the vibrational wear on the potentiometer but is more expensive. A three-pin plug is fitted as standard to most servos, resulting in a high level of interchangeability.

Fig.2 shows an exploded view of a typical servo. Item 19 is the potentiometer which in this servo is a replaceable ceramic element which screws into a housing moulded into the servo case. Modern servos use a miniature sealed potentiometer.

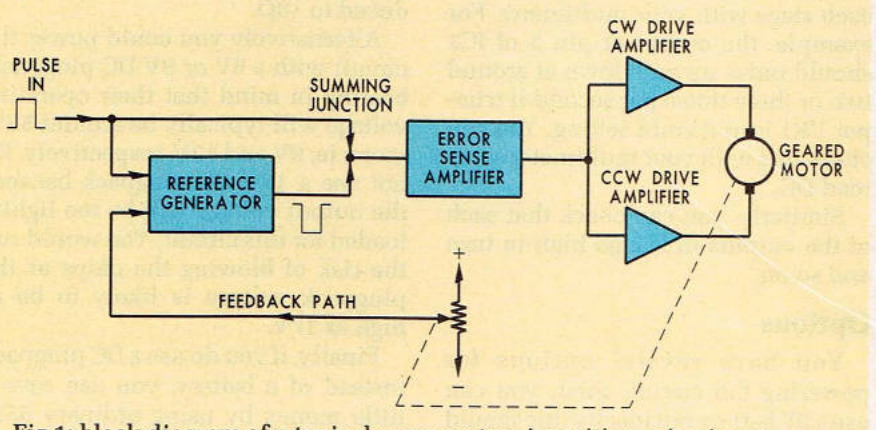


Fig.1: block diagram of a typical servo motor. A positive-going input pulse is compared with an internally generated negative going reference pulse in the error amplifier and used to drive the motor.

Pulse width modulation

The input signal to the servo amplifier is a variable width pulse and it is here that the magic begins. The position of the servo output arm is slaved (or proportional) to the width of this input pulse. Thus it can be described as a pulse width modulation (PWM) system.

Modern PWM systems have a virtually universal standard positive input pulse of 3-5V amplitude with a neutral of 1.5ms and varying between 1-2ms. The repetition rate of this pulse (Frame Rate) is typically between 14-25ms (70Hz to 40Hz) depending upon the number of channels transmitted. Don't worry if this terminology is all Greek to you at the moment. We will explain it.

The diagram of Fig.3 shows typical input pulse parameters. This pulse signal comes from the decoder which produces separate pulse signals for each servo. We will discuss encoders and decoders next month.

While the basic elements of the modern servos differ little from their early counterparts, the same cannot be said about the servo amplifier which is now just an integrated circuit with a few external components, taking up little space inside the servo case.

Example circuit

As the modern IC servo amplifier is difficult to analyse, it is easier for us

to look at a discrete servo amplifier developed before the IC took over. Fig.4 shows the circuit of an old Silvertone servo. RV is the feedback potentiometer which is coupled to the motor.

A positive-going pulse of 4.8V amplitude is fed from the receiver decoder into the base of transistor Q1 which operates as an emitter follower. The pulse signal appears across R1 in the same phase but with the base/emitter voltage drop of about 0.6V subtracted. This positive-going pulse is then fed via R6 to the summing junction and via capacitor C2 and R2 to the input of IC1, a UL914 dual OR gate.

IC1 is configured as a one-shot multivibrator with a time constant set by C3, R3 and RV. This one-shot generates a negative-going reference pulse of about 4.2V amplitude which is then fed via R7 to the summing junction R8, R9, C4, C5. The values of R5, R6 and R7 are chosen to deliver pulses of equal amplitude but opposite phase to the summing junction. R5 along with C1 also forms the supply decoupling network for the one-shot IC1.

Timing diagrams

Now we need to look at some timing diagrams which show how the input pulse and the reference pulse are summed to produce a drive signal to the servo motor.

Fig.5 shows the first condition. The top trace (a) is the positive-going input pulse while the second trace (b) is the negative-going reference pulse. When these two pulses are applied to the summing junction the result is trace (c). As you can see, the pulses have exactly cancelled out since they have equal amplitude and duration. The result is zero output, the condition required for neutral or rest position.

Fig.6 shows the conditions for clockwise drive (CW) of the servo motor. Here the positive pulse (a) is of longer duration than the negative reference pulse (b). The output of the summing junction is a positive pulse, the duration of which equals the difference between the input (positive) and reference generator (negative) pulses. This positive pulse is transferred to the bases of Q2 and Q3 via capacitors C4 and C5. As Q2 is a PNP transistor it will not respond to this positive-go-

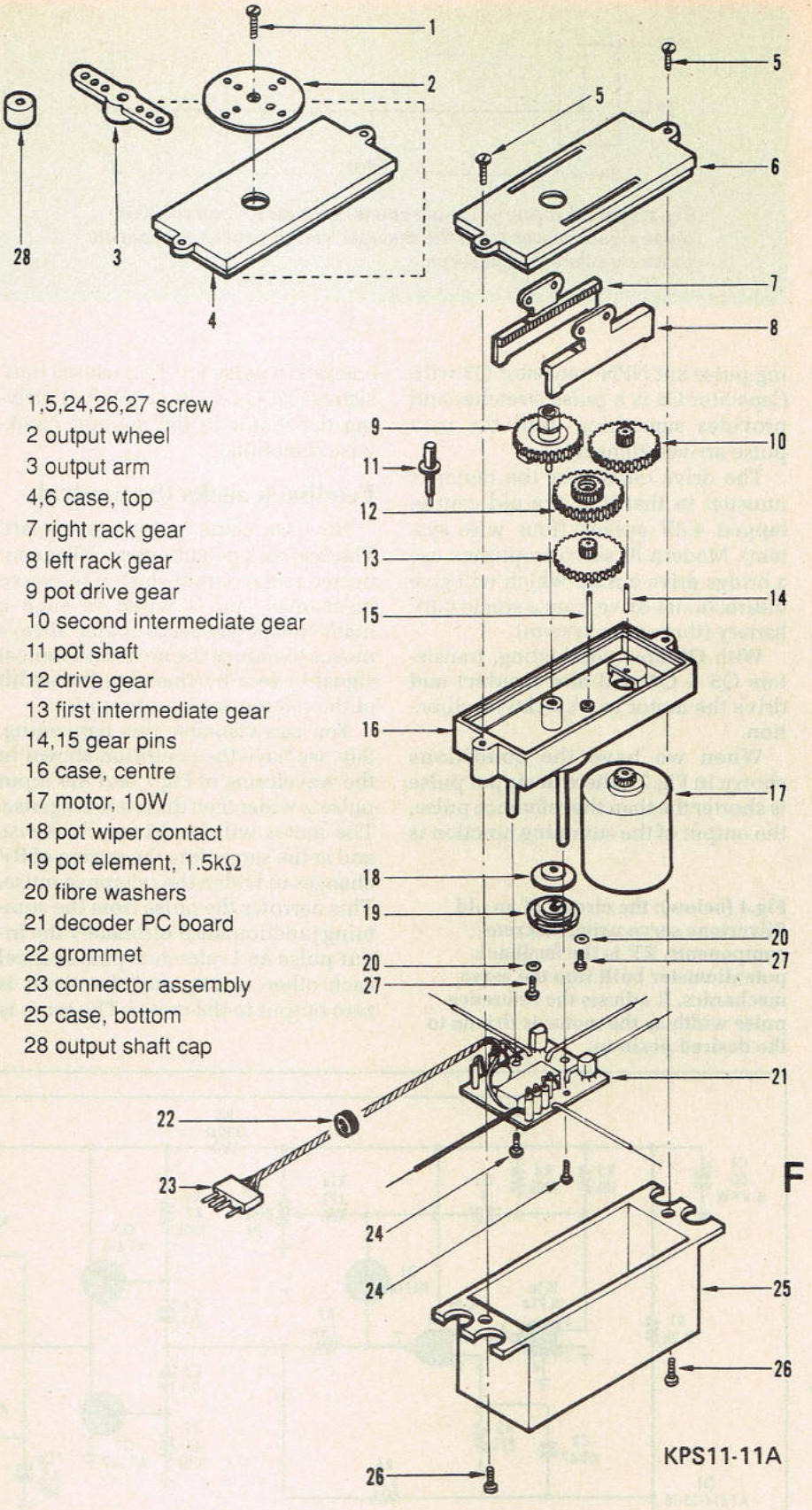


Fig.2: exploded view of a typical servo. Item 19 is the potentiometer which in this servo is a replaceable ceramic element which screws into a housing moulded into the servo case. Modern servos use a miniature sealed potentiometer.

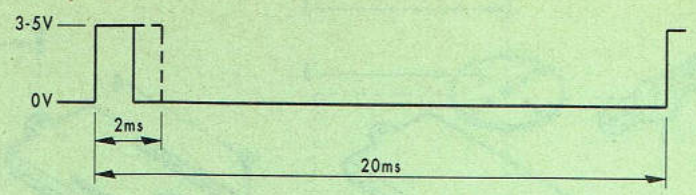


Fig.3: typical input pulse parameters for an R/C servo. This pulse signal comes from the decoder which produces separate pulse signals for each servo.

ing pulse but NPN transistor Q3 will. Capacitor C6 is a pulse stretcher and provides smoothing until the next pulse arrives 20ms later.

The drive circuit for the motor is unusual in that it is the old centre-tapped 4.8V system (four wire system). Modern IC servo amplifiers use a bridge drive circuit which will give bidirectional drive from a single 4.8V battery (three wire system).

With Q3 now conducting, transistors Q5 & Q7 will also conduct and drive the motor in a clockwise direction.

When we have the conditions shown in Fig.7, where the input pulse is shorter the than the reference pulse, the output of the summing junction is a negative pulse (c). This causes transistors Q2, Q4 & Q6 to conduct, driving the motor in the counter clockwise direction.

Feedback seeks the neutral

Now we come to the clever part. The feedback potentiometer RV is connected to the output shaft of the servo mechanics and is wired in such a manner that the servo motor always moves to reduce the error (difference) signal to zero by changing the width of the reference generator pulse.

You can visualise this happening. Say, we have the condition shown in the waveforms of Fig.7 and the input pulse is wider than the reference pulse. The motor will be driven clockwise and at the same time the setting of RV changes to widen the reference pulse. This narrows the pulse from the summing junction until ultimately the input pulse and reference pulse cancel each other exactly and the result is zero output to the motor. The servo is now in the null or neutral position and will stay that way until the input pulse changes.

The same thing happens when we have the conditions shown in Fig.8. Here the input pulse is narrower than the reference pulse and the motor is driven anticlockwise. This changes the setting of RV to reduce the duration of the reference pulse until again, the input pulse cancels out the reference pulse and the motor arrives at the neutral position.

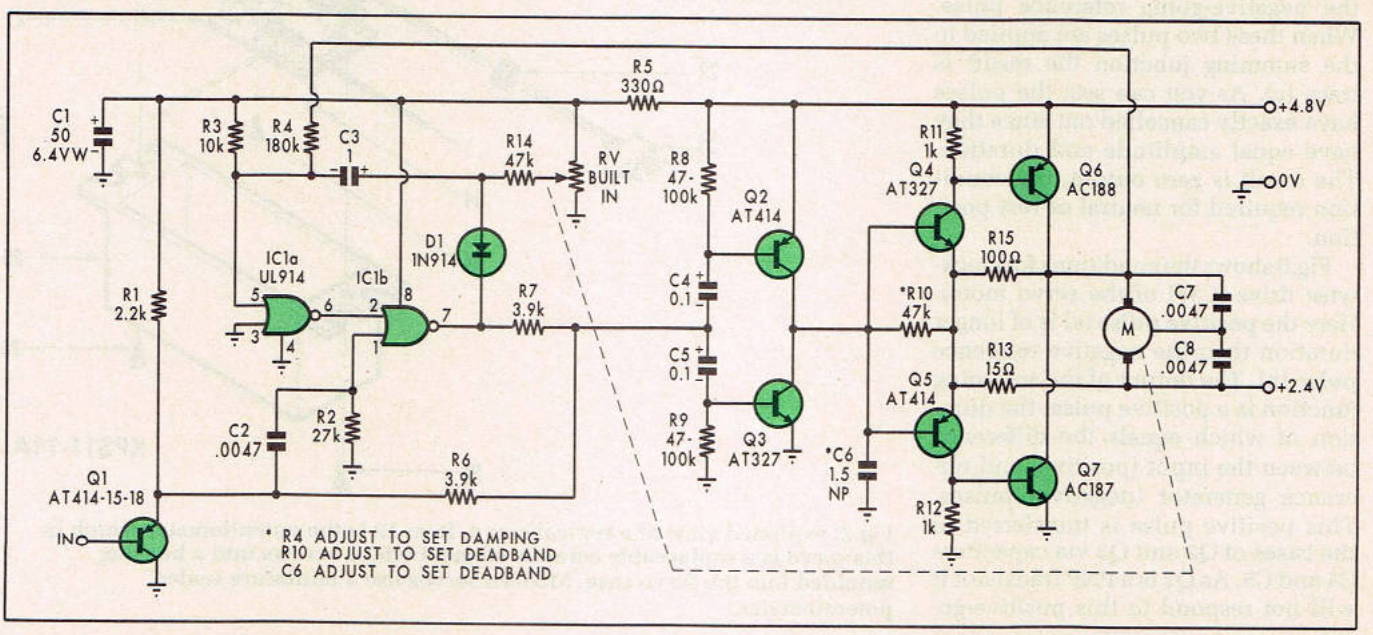
To sum up, if the input pulse is narrow, the servo will move until the reference pulse is also narrow. If the input pulse is wide, the servo will move until the reference pulse is equally wide. Relating this back to the beginning of the article when we said that the neutral pulse width is typically 1.5ms, this means that when the input pulse width is also 1.5ms, the servo seeks the neutral or null position which is usually in the centre of its travel.

If the input pulse is 2ms wide, the servo will move clockwise. If the input pulse is 1ms wide, the servo will move anticlockwise.

Servo phasing

In case you are wondering how to work out the correct sense for the potentiometer wiring let me tell you a simple way. You wire the positive and negative leads to the two outside tabs on the pot and the wiper to the lead coming from R14. When you plug the servo in, if it races down to one end of

Fig.4 (below): the circuit of an old Silvertone servo using discrete components. RV is the feedback potentiometer built into the servo mechanics. It adjusts the reference pulse width as the motor is driven to the desired position.



the throw, tearing the teeth off the output gears, you know you got it wrong. You then reverse either the two outside wires on the pot or reverse the two motor wires but not both and the servo operates normally.

These days the servo manufacturers usually wire the motor and pot leads directly into the amplifier PC board and servo reversing is no longer possible. Servo repairing is no longer possible or cost effective in most cases, thereby increasing the pressure on transmitter designers to provide servo reversing at the transmitter end.

To tidy up the remaining parts of the amplifier description, R14 is the feedback voltage set resistor, setting the throw of the servo. The higher the value of R14, the more travel required before sufficient control voltage was available to null the error. R3 will also provide throw adjustment. Throw is defined as the amount of angular displacement on the output arm for any given pulse width variation.

D1 is an isolation diode. R8, R9 & R10 also act as base tie-down resistors for thermal stability. R13 is a current limiting resistor. Capacitors C7 & C8 are connected from each motor terminal to the case. These capacitors must be mounted on the servo motor and form the noise suppression network for the motor. R15 prevents both sides of the amplifier switching on simultaneously.

Damping

R4 is the main damping resistor, advancing or retarding the reference pulse generator slightly according to the direction of rotation. In this way the motor drive can be shut down just before the null point is reached, allowing the servo to coast smoothly to a stop at the correct position.

In a feedback system there are three types of damping conditions possible: under-damped, over-damped and dead-beat. An under-damped servo will swing past the neutral point and then kick back past neutral and kick back again in increasingly small oscillations until the zero error point is reached.

An over-damped servo will shut down well before the zero error point is reached and slowly creep back to neutral. The dead-beat servo will come straight back to the correct neutral with no over or undershoot. By adjusting R4 the correct amount of refer-

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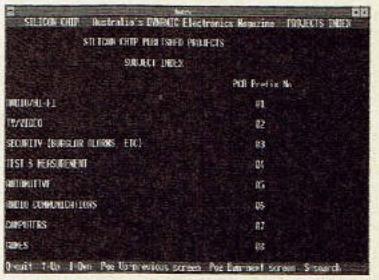

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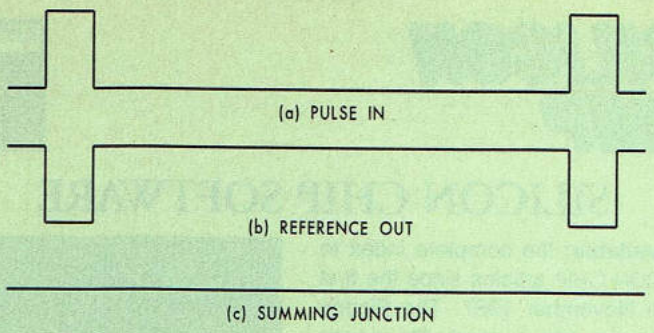


Fig.5: the top trace (a) is the positive-going input pulse while the second trace (b) is the negative-going reference pulse. When these two pulses are applied to the summing junction the result is zero output (c), the condition required for neutral or rest position.

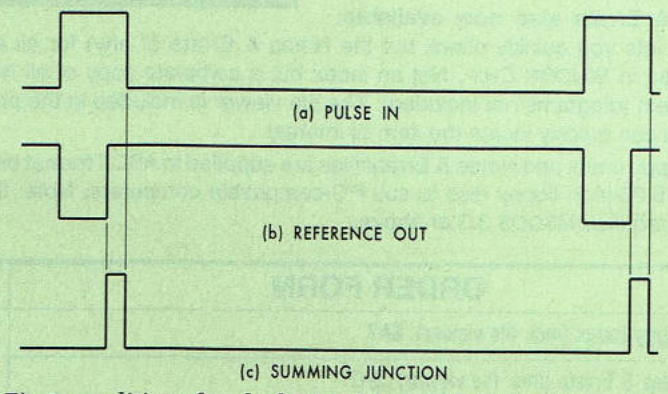


Fig.6: conditions for clockwise drive (CW) of the servo motor. Here the positive pulse (a) is of longer duration than the negative reference pulse (b). The output of the summing junction is a positive pulse, the duration of which equals the difference between the input (positive) and reference generator (negative) pulses.

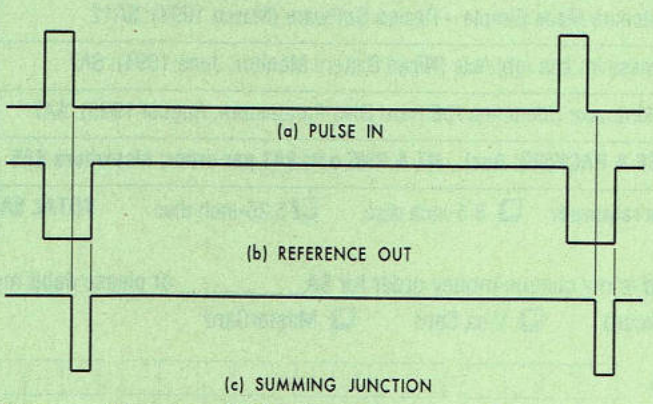
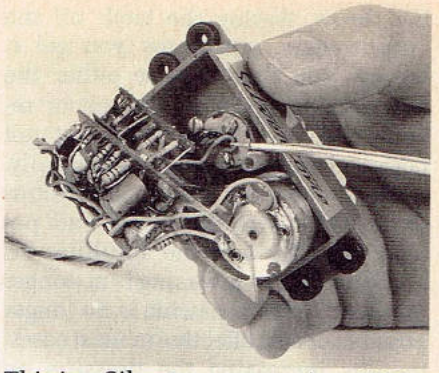


Fig.7: conditions for CCW drive. The input pulse is shorter the than the reference pulse, so the output of the summing junction is a negative pulse (c) which drives the motor anticlockwise.

ence generator adjustment may be achieved. A slightly under-damped servo (one kickback) is the best compromise for heavily loaded servos.

Setting the damping on any servo is the most difficult part of the servo design. The problem begins with the pulse stretching network and encompasses such factors as servo power, slew rate, operational load, dead band and most importantly the minimum impulse power of the servo amplifier. The dead band is the notch that the servo comes to rest in. If this notch is too wide, then centring inaccuracies occur; if too narrow, the servo chatters away because it cannot find a spot to come to rest. This results in excess current being drawn by the servo, overheating of the amplifier and brush wear on the motor.



This is a Silvertone servo, circa 1973, showing the double deck amplifier board complete with 11 transistors. Also visible is the drive motor and feedback potentiometer.

The minimum impulse power of the amplifier is the ability of the amplifier to obtain the maximum torque from the motor on the minimum error pulse. The higher the minimum impulse power the better the resolution of the servo and the less demands on the damping network. As you can imagine, if the servo is over-damped and it shuts down too early it must rely on the minimum impulse power to creep it back to the correct neutral.

If the servo is heavily loaded and with too high a dead band, then the servo may sit just short of the correct neutral, introducing a control error which is annoying to the operator of the model. Worse still the servo is drawing excessive current, reducing battery life and overheating the transistors. Four or more servos doing this could reduce battery life to half and possibly result in a crash.

So there you have it! Now you should have good understanding of the theory of servo operation. Just coincidentally, next month's Circuit Notebook will include a servo based on a windscreen wiper motor. The operating principles are the same.

Next month we will look at how the input pulse arrives via a remote or local link. **SC**

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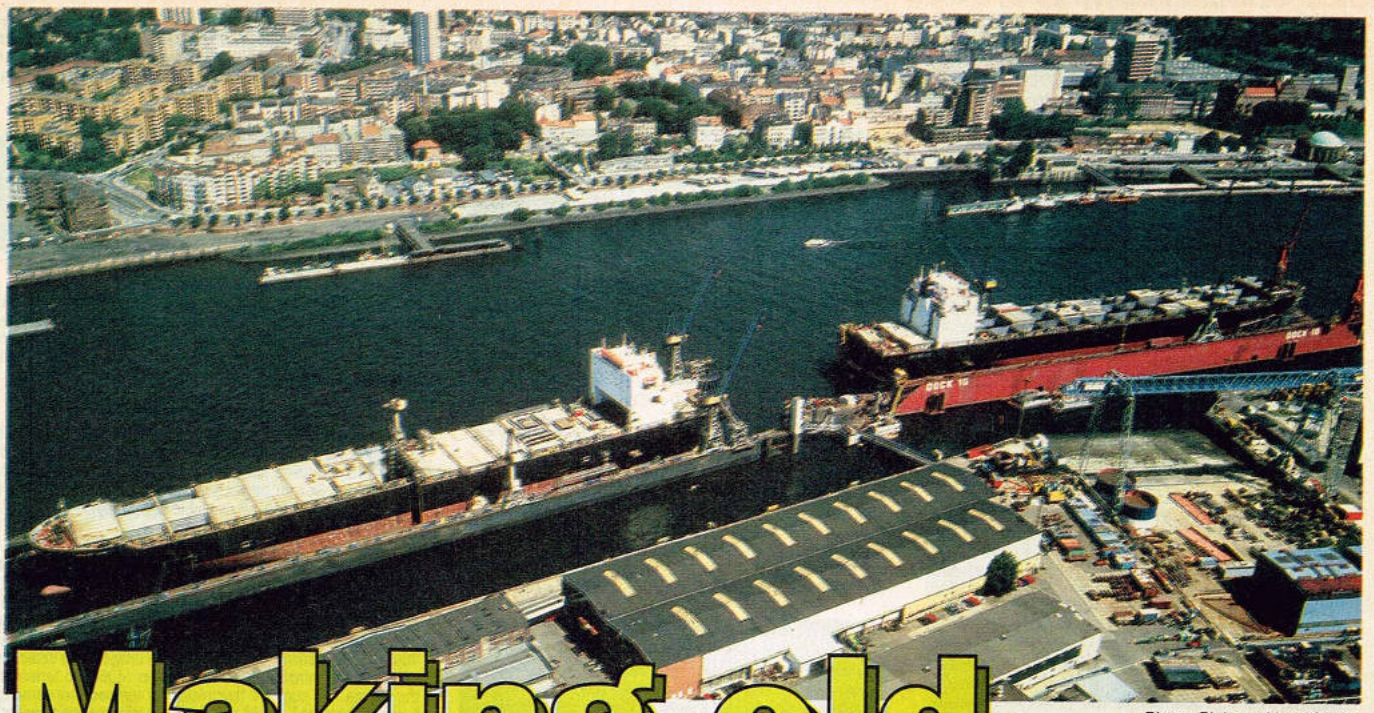


Photo: Blohm + Voss GmbH

Making old ships go faster

A new marine propulsion system using an ABB motor and generator has boosted the speed of three rebuilt US container ships from 18 to 21 knots. Instead of "power take off" (PTO), it makes use of the "power take in" (PTI) concept to transmit 4000kW to the ships' main shafts.

Three US container ships were recently upgraded at the Hamburg shipyard of Blohm + Voss GmbH by shortening the vessels and installing a new marine propulsion system.

The reasons for the modifications to the three vessels were straightforward. Operators of container ships have had to adjust to a vastly changed economic situation in recent years. The need today is for faster, smaller container vessels with a capacity of 2500 to 6000 TEU (equivalent unit for 20-foot containers) and able to travel at a speed of at least 21 knots.

Recognising this trend, the Sea-Land Division of CSX Corporation in the USA began looking for ways to modernise its large and relatively slow container ships. These were built in Korea in the early 1980s for United States Lines (USL).

The vessels, which when new were among the most economical container ships in service, originally had a storage capacity of approximately 3900 TEU and a speed of 18 knots. USL operated the ships as Atlantic Class Vessels (ACV). Ten years later, speed has become the dominating factor for these vessels, with large container capacities given only a second priority.

The most obvious way to increase the speed of the ships was to reduce their length and to equip each of them with a new forebody and afterbody plus a new propulsion plant. However, that idea was rejected as being economically inviable.

SL-31 – a brand new concept

The shipyard and shipowner eventually agreed on a completely new concept. The project name that was chosen was SL-31 (SL stands for Sea-Land, 3 for 3000 TEU and 1 for 21 knots). It proposed a reduction in the length of the ACV container ships by three hatch groups (bringing their length down from 279 metres to 248 metres), a more streamlined forebody and a higher power rating for the propeller.

Extensive calculations and tests

were carried out by the shipyard at the HSVA marine test institute in Hamburg to make sure that a speed of 21 knots would actually be achieved. An increase in the drive power rating would be necessary, as would modifications to the shape of the forebody.

The changes that had to be made to the body of the ship called for precision work. For example, during the removal of the midbody, a flame-cut with a length of 330m had to be made in one operation and with an accuracy that would ensure that no re-machining of the storage structures would be necessary after the forebody and afterbody had been floated back together again. In addition, the electrical power connections between the two halves of the ship, involving about 350 cables and large numbers of pipes, had to be separated.

After the midbody had been cut out and temporary bulkheads had been fitted, the forebody and the midbody were floated and pulled out of the dock by tugs. After this, the forebody was moved to within about 300mm of the afterbody. The dock was then floated again and the forebody pushed up against the afterbody, aligned, tacked and welded in place.

The most critical part of this operation was the manoeuvring and alignment of the two halves. Very high precision was necessary, as a deviation of just a few millimetres from the original longitudinal axis would translate into a loss of speed. Optical measuring equipment was used to ensure a perfect fit.

It is worth remembering that the parts being manoeuvred weighed several thousand tonnes and that they had to be moved by tugs to precise positions in the dock. This part of the modernisation alone was a considerable achievement on the part of the shipyard.

The "Sea-Land Pride" in Dock 10 after the forebody had been cut away and with the midbody being prepared for removal. The photo on the facing page shows the ship after conversion. Next to it, on the left, is the "Sea-Land Value".

Increasing the drive power

A new approach was also necessary for the upgrade of the propulsion systems. The installed machines, Sulzer 7 RLB 90 engines, were rated at 20,590kW (100%) and 18,530kW (90%). In order to run the ships at 21 knots without modifying the vessels, it would have been necessary to increase the engine power to about 30,000kW.

By streamlining the forebody through hydrodynamic improvements, an initial power saving of 3700kW could be achieved. Also the reduction in length by three hatch groups reduced the ships' frictional resistance, allowing a further saving of 1500kW (or 5200kW in total). This meant that, to achieve the required speed of 21 knots, an additional 3800-4000kW would have to be fed into the propeller shaft system.

To raise the drive power rating to

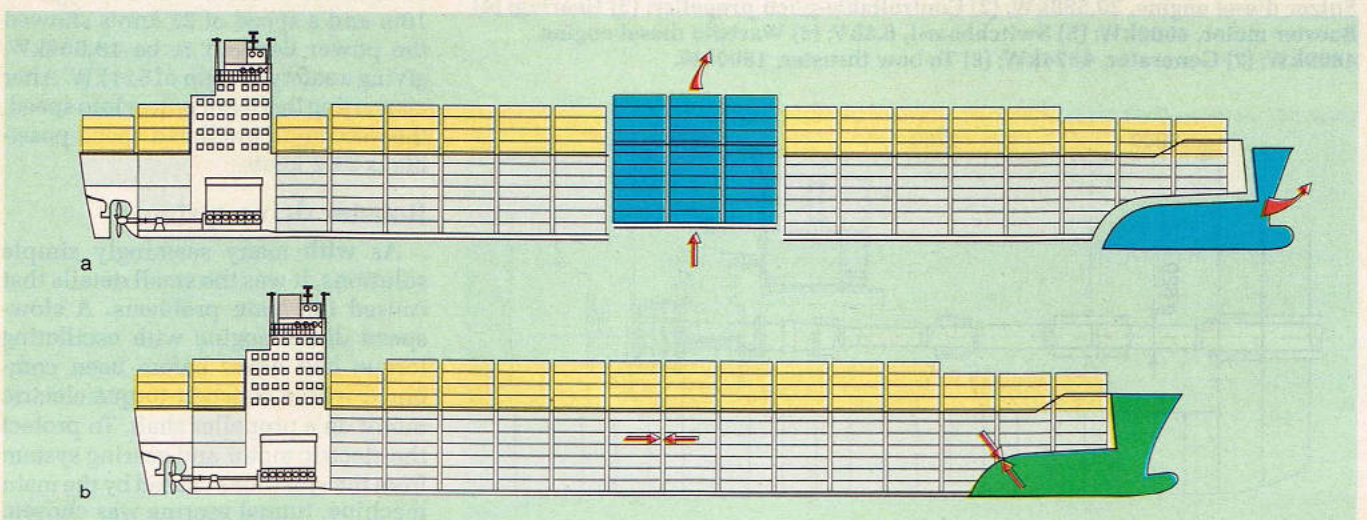


Fig.1: ACV container ship conversion based on the SL-31 concept: (a) forebody cut away and midbody removed; (b) shortened ship with new forebody.

This photo shows the new, more streamlined forebody being fitted to the "Sea-Land Pride".

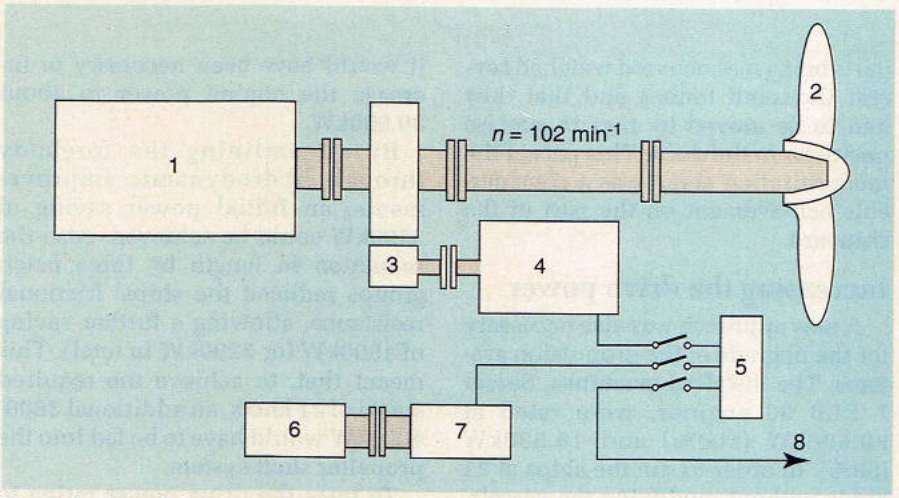


Fig.2: design of the new marine propulsion system with booster motor: (1) Sulzer diesel engine, 20,588kW; (2) Controllable-pitch propeller; (3) Gearing; (4) Booster motor, 4000kW; (5) Switchboard, 6.6kV; (6) Wartsila diesel engine, 4860kW; (7) Generator, 4374kW; (8) To bow thruster, 1800kW.

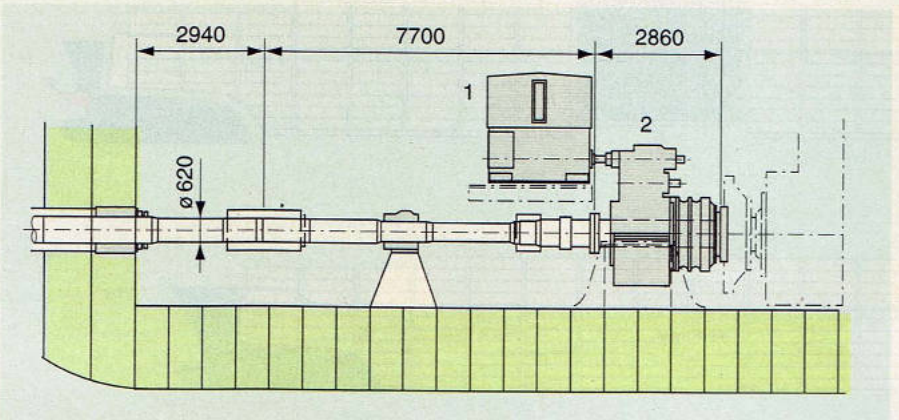


Fig.3: shaft arrangement for the booster motor and tunnel gearing: (1) Booster motor; (2) Tunnel gearing.

the required level, Blohm + Voss GmbH developed a new, unconventional concept that "reverses" the standard shaft generator system commonly in use. Previously, electrical power has been fed into the onboard power system from the main machine by means of a gear system with an attached generator.

The new drive makes use of the "power take in" instead of "power take off" concept (Fig.2). In this method, 4000kW is transmitted via a 6.6kV electric motor to the main drive shaft by means of tunnel gearing which is flanged via a Vulcan coupling to the flywheel of the main machine (see Fig.3). The electric motor is fed with 4860kW (100%) or 4374kW (90%) from an additional Wartsila-Diesel generator set with a 6MVA alternator. The high-voltage switchgear and diesel-generator set are installed in a new engine room on the main deck. Many new, innovative control features were required to link the slow-speed main machine to the electric motor via the tunnel gearing.

New propeller

The power is transmitted to the water by a new controllable pitch propeller with a diameter of 7.1 metres. This propeller can absorb up to 24,400kW which is also the maximum power transmitted to the shaft. Although the new propeller is 0.5m smaller in diameter than the original unit, its special shape enables it to produce 20% more power.

Using the machine data as a basis, the propeller power was calculated to be 19,160kW. Tests with a draught of 10m and a speed of 21 knots showed the power demand to be 18,639kW, giving a safety margin of 521kW. After converting this extra power into speed, the maximum predicted speed possible is 21.2 knots.

Booster drive system

As with many seemingly simple solutions, it was the small details that caused the main problems. A slow-speed diesel engine with oscillating torque had never before been combined with a constant-torque electric motor on a propeller shaft. To protect the electric motor and gearing system from the vibrations caused by the main machine, tunnel gearing was chosen. This transmits the electric motor power via a multi-disc clutch to the

gear system and then via a Vulcan coupling direct to the flywheel of the main machine and the propeller shaft. The energy flow in the shaft is shown in Fig.4.

To enable the two different systems to be used together, new automatic controls had to be developed for the drive system. These had to be completely reliable in every operating mode. This problem alone presented a major challenge, especially in view of the limited time that was available for the development work. For this particular application, a new digital control system was installed.

The new main-machine/booster system was rigorously tested by the US Coast Guard (USCG) and the American Bureau of Shipping (ABS) with the help of Failure Mode Effective Analysis (FMEA). This involved a run-through of all possible service profiles, both in the dock and at sea, to ensure the safety and reliability of the booster system.

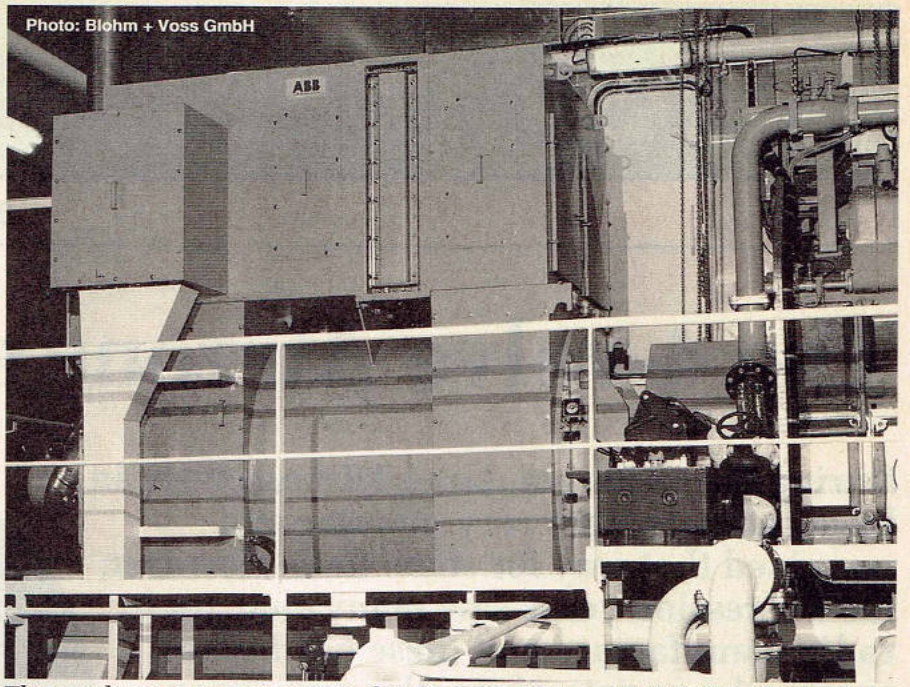
The new electrical auxiliary system for the booster installation receives its power from the booster diesel-generator set via a 6600/480V, 500kVA transformer.

Booster drives bow thruster

Since the booster diesel-generator is not required for docking manoeuvres or when the ships are in port, it can also be used to drive the newly installed ABB bow thruster. Thus, the booster diesel-generator has two tasks in that it supplies: (1). additional energy for the main drive (PTI); and (2). drive power for the bow thruster.

The diesel-generator set supplies power to a 6.6kV substation with load feeders to the booster motor, the bow thruster and an auxiliary transformer.

For this project, the Marine, Oil and Gas Industry Division of ABB Industrietechnik AG supplied the electrical booster plant, the electrical equipment for the bow thruster and all of the cabling for the electrical systems. During the conversion, it was necessary, among other things, to shorten all of the cables to the forebody. This involved cutting a 40m-long section out of approximately 350 cables and then reconnecting the cables using heatshrink joints. This work was carried out in close collaboration with the shipyard and the suppliers of the other systems to ensure full compliance with ABS and USCG regulations.



The new booster generator is used to feed an additional 4000kW (before losses) to the main drive shaft.

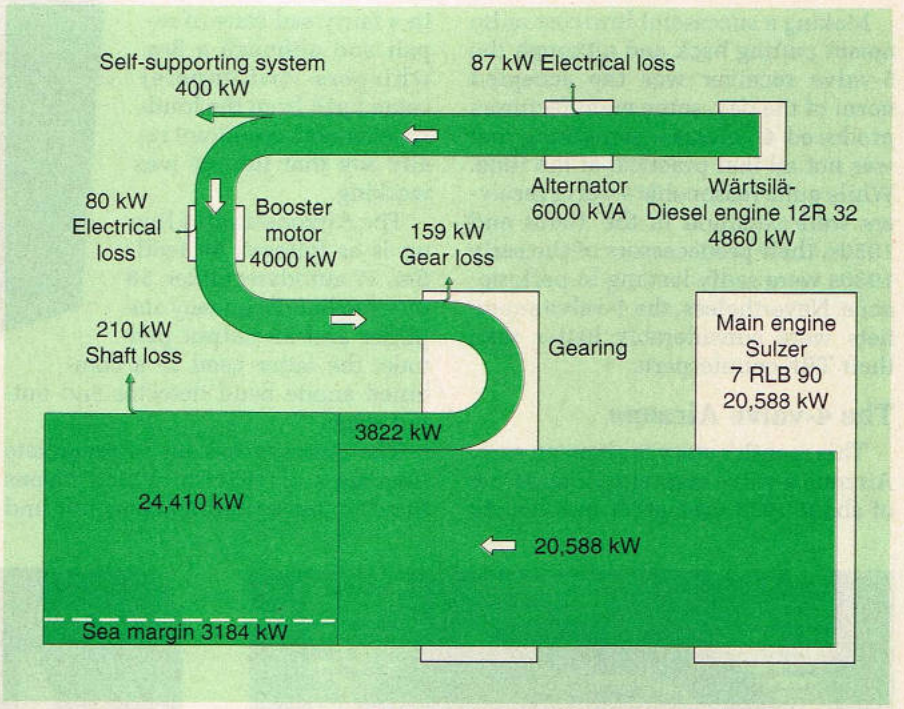


Fig.4: energy flow in the propeller shaft.

Sea trials with the first ship to be completed, the Sea-Land Pride (formerly Galveston Bay), were carried out in the summer of 1994 and underscored the success of the project. The vessel, which had been running with a speed of 18 knots, achieved 19 knots without the booster system and almost 22 knots with it. In the same year, its two sister ships, Sea-Land Value and Raleigh Bay, were also handed over to the customer after successful conversions. **SC**

Acknowledgement: this article has been adapted from an article that appeared in the March 1997 issue of ABB Review, published by Asea Brown Boveri Ltd.

VINTAGE RADIO

By JOHN HILL

The 4-valve Airzone superhet

During the 1930s era, large TRF receivers in huge cabinets were very popular and remained that way for some time. However, the depression years saw many changes in radio manufacture and these hard times spawned a variety of smaller and cheaper receivers.

Making a successful low-cost radio meant cutting back and although the 5-valve receiver was the accepted norm of the day, some manufacturers produced 4-valvers – something that was not all that practical at the time. While quite reasonable 4-valve receivers were common in the 1940s and 1950s, their predecessors of the early 1930s were sadly lacking in performance. Nevertheless, the 4-valve superhets were considerably better than their TRF counterparts.

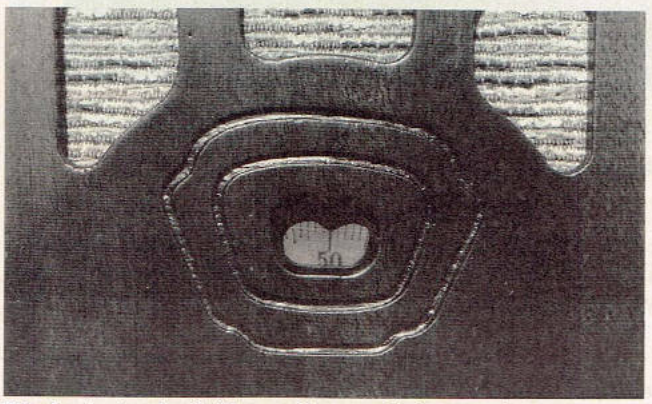
The 4-valve Airzone

This month's story is about an early Airzone 4-valve mantel style superhet of about 1933 vintage. It was bought in a fairly sad state of repair and although a few whispers (whimpers) came forth from the loudspeaker, one could not really say that the set was working.

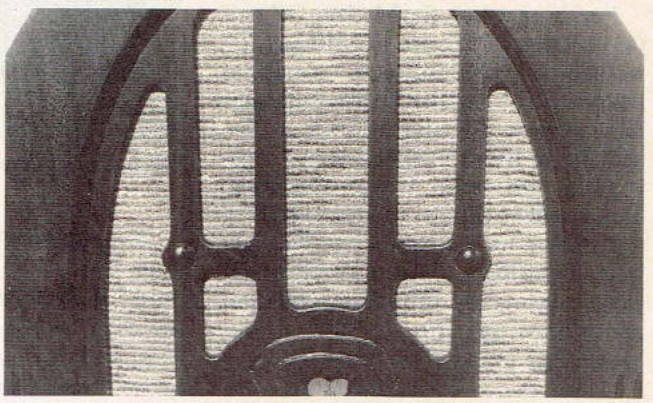
The Airzone's valve line up is as follows: 80 rectifier, 57 autodyne mixer, 58 intermediate frequency amplifier and 59 output pentode, the latter used as a combined anode bend detector and output stage.

The Airzone has an intermediate frequency of 465kHz, which means that the 3-gang tuning capacitor and

The Airzone 4-valve superhet, circa 1933. A semi-gloss lacquer treatment seemed appropriate for the age of the receiver.



The budget-priced Airzone has no dial escutcheon. Instead, it features two routed grooves around a heart-shaped peephole dial aperture.



The speaker grille cloth was reversed so that its clean side showed through the front of the cabinet. This trick is well worth remembering if you are restoring an old receiver.

bandpass filter used on early superhets with 175kHz IFs were not required. That in itself would amount to a worthwhile reduction in production costs.

Anode bend detection had been used in radio receivers for some time and was the current trend when the Airzone was made. However, using this method of detection on the output valve was a departure from the normal practice of putting the detector ahead of the output stage.

Anode bend problems

Using the output valve as an anode bend detector creates a number of problems. First, because the valve is biased to work near cut off, its plate current is considerably reduced. This means that the set requires an output transformer with a much higher than normal primary impedance, otherwise its output power will be well down compared to that from a conventional class-A output stage.

Second, because of the reduced plate current, there is insufficient current flowing through the field coil to adequately energise the speaker magnet, if a standard 2kΩ field resistance is used. This speaker problem was overcome by employing a tapped high resistance winding. Other 4-valve receivers did use standard speakers but the circuit was designed to bleed off sufficient high tension current to energise the field.

It wasn't until diode detection came into general use that the output valve was used as a conventional output stage in these early 4-valve superhet receivers. When diode detection was used, the diodes were usually enclosed in the IF amplifier valve. The old 6B7 and type 55 valves had built-in diodes and were much used during the mid-1930s.

But let's return to the old Airzone.

Budget market

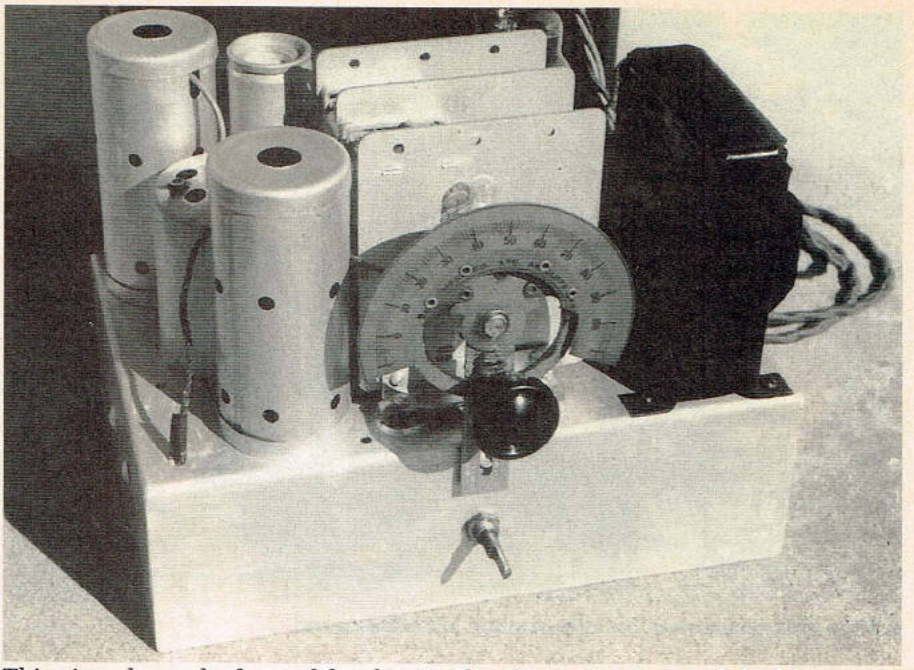
This receiver was undoubtedly aimed at the budget end of the market. Its manufacture was so cost-effective that the lightweight plywood cabinet has no dial escutcheon and relies on a routed shape in the front panel to substitute for this common embellishment. Most receivers of that era had either a pressed brass or moulded bakelite escutcheon but not the old Airzone!

The dial pointer takes the form of a heart-shaped peephole cut into the front panel. If a radio manufacturer was to survive in the early 1930s he had to trim costs in every way imaginable. Airzone successfully did this and was still making radios well into the post-war period.

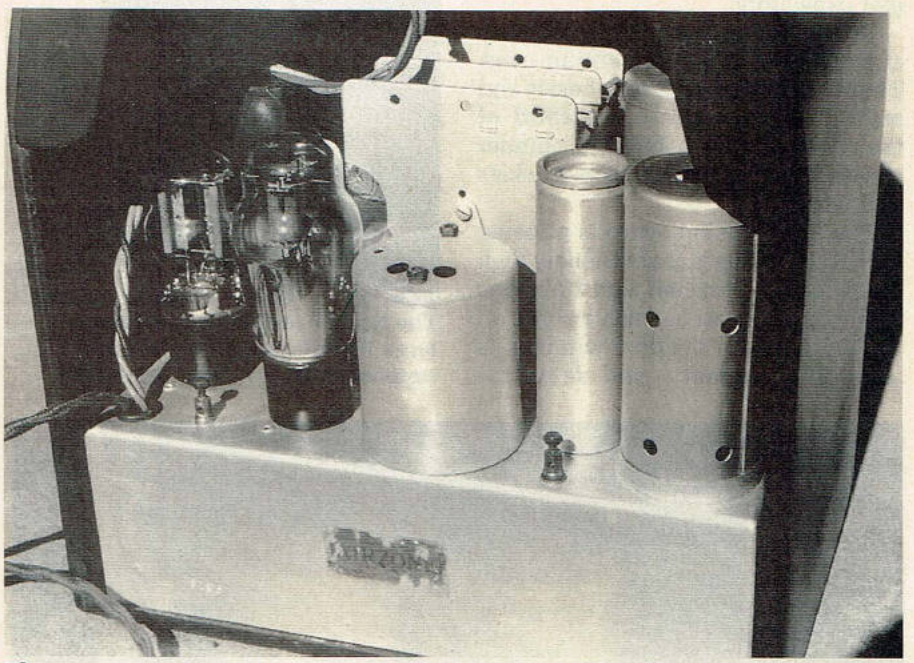
The speaker is the original Magnavox 150D, a 6-inch (150mm) electrodynamic type with a tapped field winding. The field winding has an impedance of 6kΩ and is tapped at 3.5kΩ. The original high-impedance output transformer was still attached to the speaker.

Fortunately, both the tapped field and the output transformer were still in working order. As might be expected, these somewhat rare items are difficult to find and expensive to buy or have rewound.

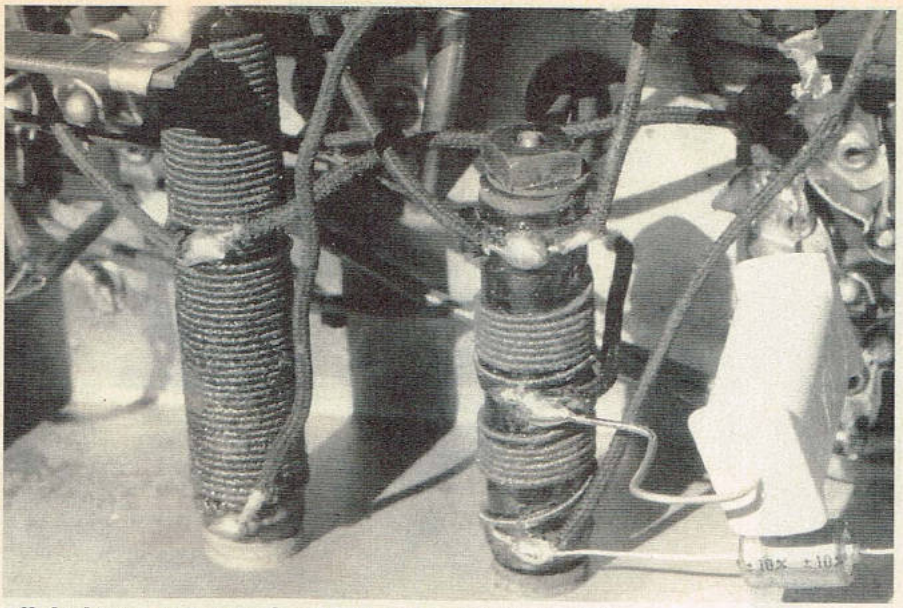
The IF transformers are mounted



This view shows the front of the chassis after the restoration work had been completed.



This rear view shows the chassis inside the cabinet. The old receiver cleaned up quite well, despite its initial condition.

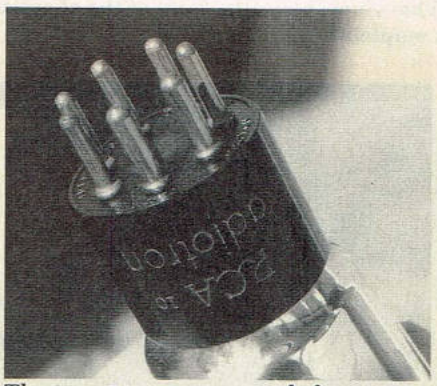


All the bias resistors in the old Airzone are wirewound.

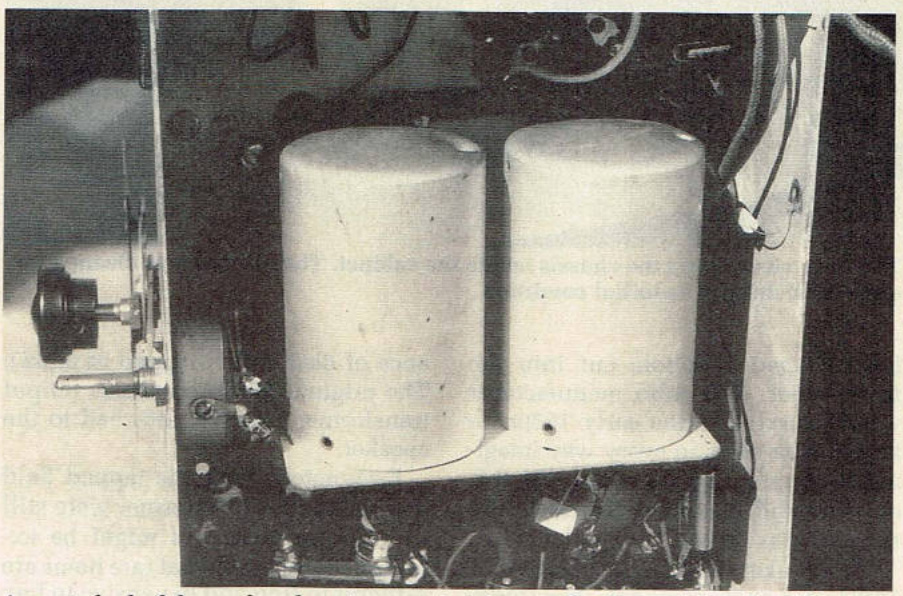
on top of the chassis in large aluminium cans and are adjusted by trimmer capacitors.

The aerial and oscillator coils are also mounted in large aluminium cans. These are underneath the chassis and occupy approximately one third of the available space below. They hinder access to some of the valve sockets and wiring.

The high tension setup is unusual in that the voltages are extremely high (460V at the rectifier) and only one filter capacitor, an 8µF electrolytic on the input side of the field winding, is used. The original – and defunct – wet type was replaced with a new 10µF 500V unit.



The type 59 output pentode has a large 7-pin base which gives the suppressor its own pin connection.



A great deal of the under-chassis space is taken up by the aerial and oscillator coils. These units restrict access to several valve sockets, making voltage checks quite difficult.

The wirewound voltage divider and cathode bias resistors are unusual in that they are wound like a bunched filament in a light globe, thus making very compact units.

Also of unusual design is the type 59 output pentode in that it has two cathodes and a suppressor grid that connects to a separate base pin. Even with one heater out of action, the old 59 will still work reasonably well. While most other pentodes have the suppressor grid connected internally to the cathode and use a 6-pin base, the 59 has a pin connection for the suppressor and a large 7-pin base.

Anode bend detector

The output/detector has a very high cathode resistor of around 4kΩ, which operates the valve near its cutoff point. This is necessary for a valve operating as an anode bend detector.

When set up in this manner there will be pulses of anode current during positive half-cycles at the control grid and little or no current during negative half-cycles. Thus, the valve rectifies or detects the radio frequency signal applied to its control grid.

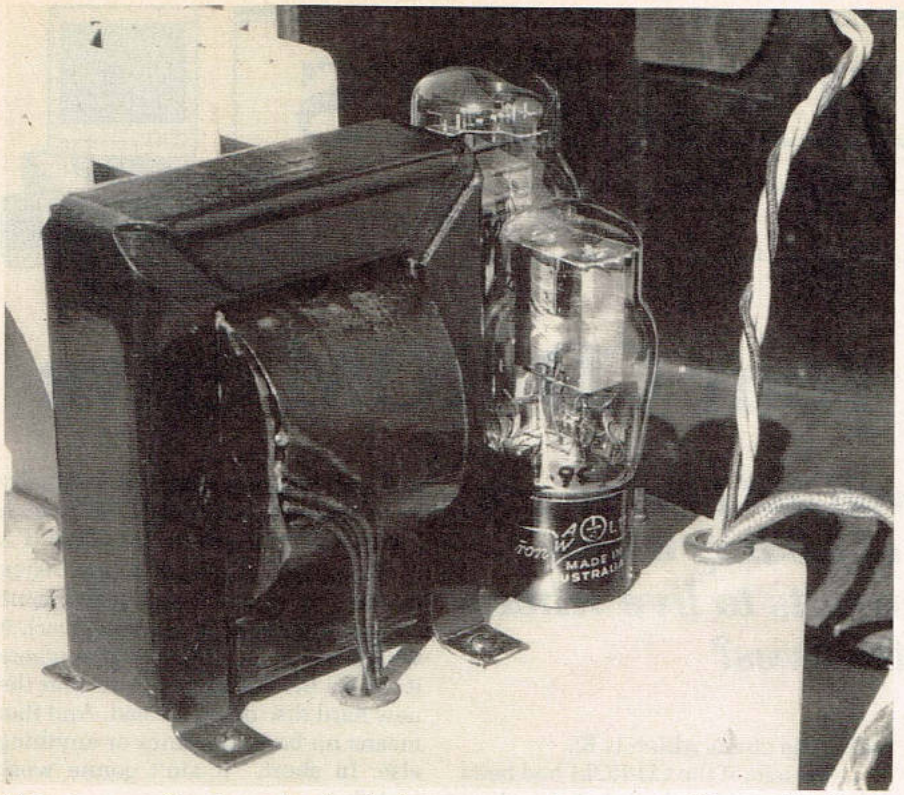
Inserting a milliamp meter in the output valve's cathode connection was an interesting experiment. Total valve current varied between 6-10mA, depending on the signal strength at the control grid. If set up as a normal class-A output stage, a 59 would pass about 44mA. The cathode bias voltage is around 40V.

Another point worth mentioning is the fact that, because of the low current flow, the valve does not operate at a very high temperature. One can grasp it firmly without being burnt. Even the rectifier works much cooler but is still too hot to hold for long.

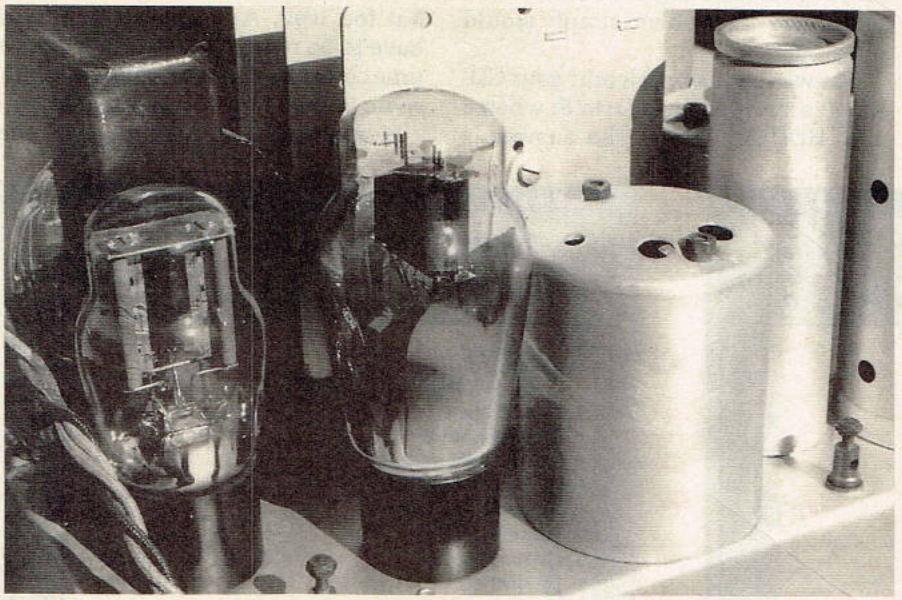
Plate voltages throughout the Airzone are extremely high, with 320V on the 57, 350V on the 58 and 360V on the 59. I guess that's one way of squeezing out that extra performance.

Repairs

The repairs involved replacing the paper capacitors and the previously mentioned 8µF electrolytic. Due to the high tension supply being so elevated, 630V capacitors were used throughout as some would be stressed at close to 500V potentials during the warm-up period.



The power cord and speaker leads share a common grommet. The speaker has no plug and is wired directly into the circuit.

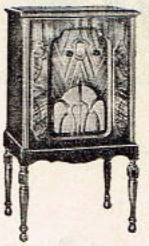


This view shows the 80 rectifier and the 59 output detector. Note also the large IF transformer and the single wet type electrolytic capacitor.

The cabinet required the usual regluing treatment and was refinished in semi-gloss. The speaker grille cloth was dirty but otherwise in reasonable condition. Turning it back to front soon solved that problem.

All things considered, the old 4-valve superhet Airzone is a fairly unusual receiver when compared to the 4-valvers that followed in the diode detection era. While it was originally marketed as an economy model, it is nevertheless a very collectible item today – particularly as it is housed in a "Cathedral" style cabinet and retains its original speaker setup. **SC**

Vintage Radio



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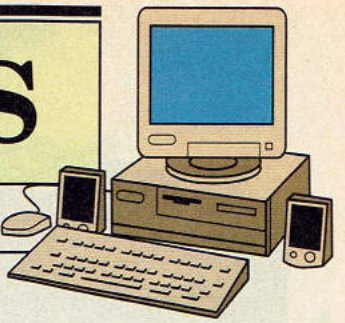
BY JASON COLE



Relocating your CD-ROM drive

Windows 95 works well but how do you correct the problem of adding a new hard disc drive that wants to live where the CD-ROM currently lives?

Hard disc drives (HDDs) have dramatically increased in size in the last couple of years, while prices have gone the other way. The only problem is that when you buy your new HDD, it generally becomes the secondary or D: drive while the older unit is kept as the C: drive (so that you don't have to reinstall the operating system). This is fine except that your CD-ROM is now assigned the next drive letter along the chain which is E:.

Of course, if the CD-ROM had been assigned a higher drive letter such as R: in the first place, then all would be well. It would retain its drive assignment when extra hard disc drives were added and the problem simply would not arise.

But why is it a problem if your CD-ROM is shuffled from D: to E: when a new HDD is added? The answer is that any program that was originally installed from the CD-ROM, and which refers back to the CD-ROM while it is running, will no longer work. When it's time to load that wonderful game called "LightHouse" (or whatever), it will go to the drive assignment where it thinks the CD-ROM is and find the new hard disc drive instead. And that means no fancy graphics or anything else. In short, "it ain't gonna work mate".

One way to correct this problem is to reinstall all the CD-ROM based software. However, this might not work out too well. Any patches will also have to be reinstalled and this can be time consuming and troublesome with some of the older software packages.

A more elegant way to solve the

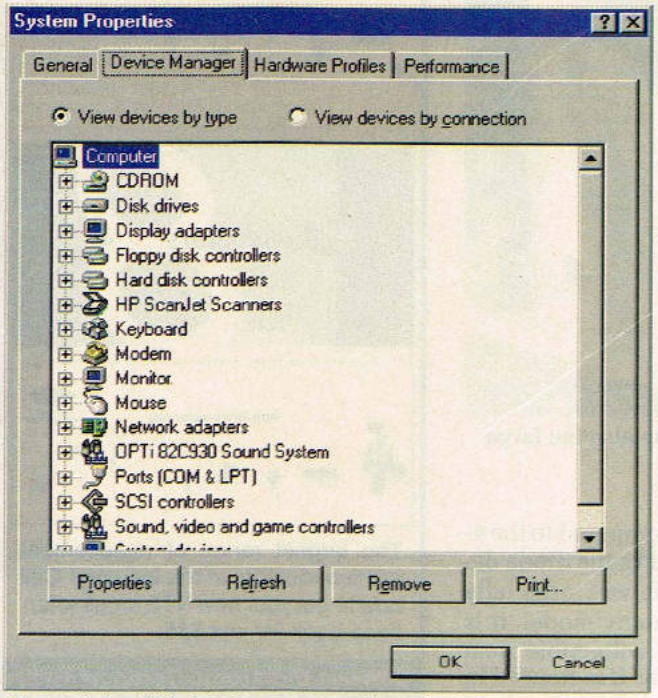


Fig.1: right click My Computer, then click Properties and select the Device Manager tab to bring up this dialog box.

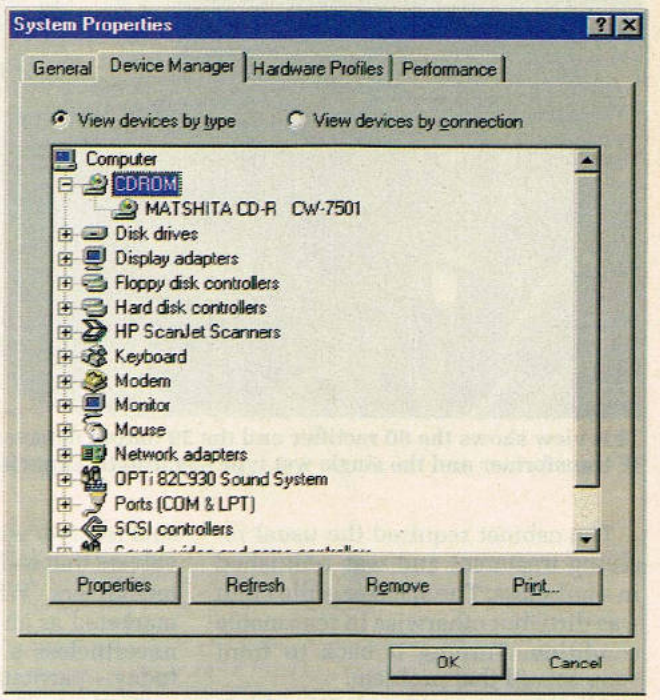


Fig.2: double-click the CD-ROM option so that it expands to show the currently installed CD-ROM drive.

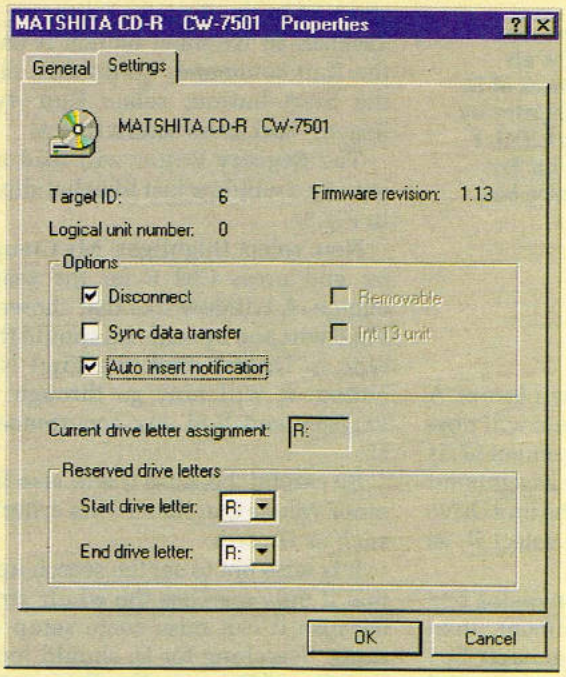


Fig.3 (left): selecting the CD-ROM drive, then clicking Properties and selecting the Settings tab brings up this dialog box. The current drive assignment is shown towards the bottom and you can change it by clicking the down arrows and selecting a new assignment (eg, R:).

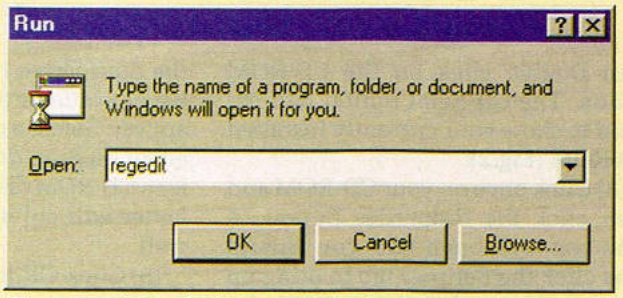


Fig.4: you launch the Registry Editor by clicking Start, Run and typing regedit on the Open line.

problem is to change all pointers to the old D: drive to the new CD-ROM assignment. This is done by delving into the subterranean depths of the Registry. Now I know that I have warned about the dangers of delving into the Registry in the past but there are times when it is necessary.

Back it up

Now remember, the Registry is really, really important to the correct operation of Windows 95. For this reason, make a backup of it first so that you can restore it if you make a mistake. The Computer Bits column in the September 1997 issue tells you how to make Registry backups.

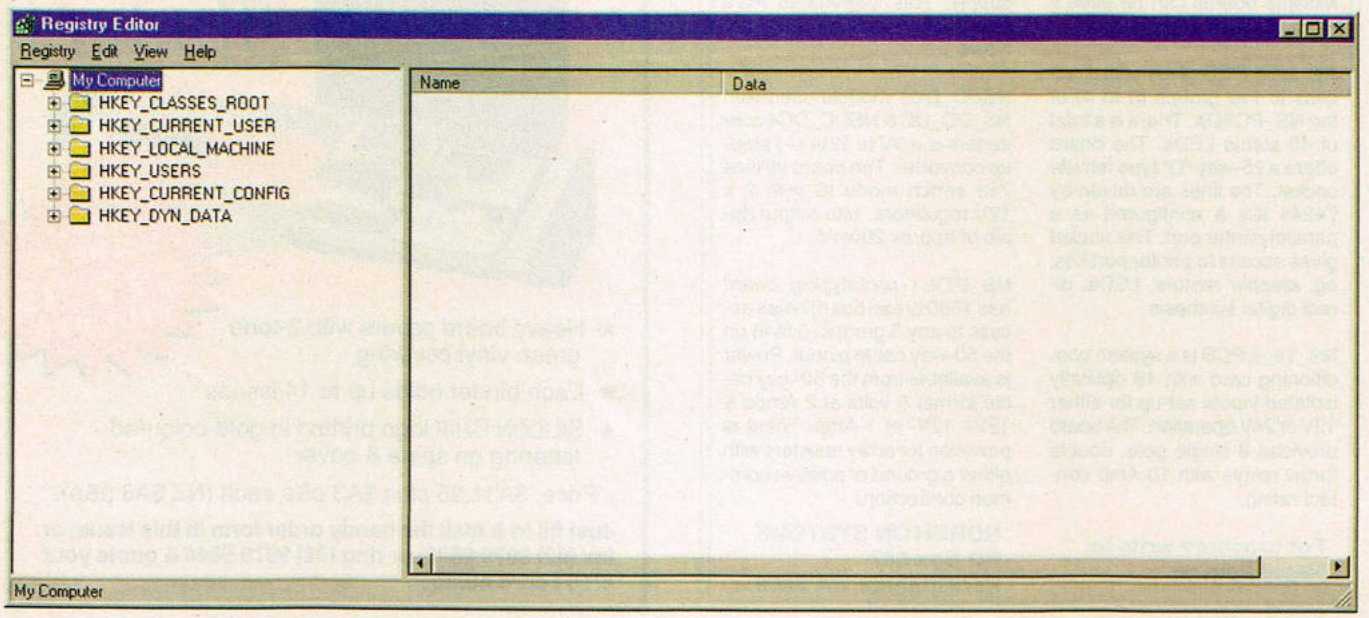
Also, make sure Windows 95 is working correctly in the first place. It's pointless fixing the brakes if the wheels are square!

Before starting, I have found that it's best if the CD-ROM is changed to another drive assignment before you install the second hard disc drive. To do this in Windows 95, just follow these simple steps:

(1). Right click on My Computer (on the desktop) and select Properties to bring up the Systems Properties box.

(2) Click the Device Manager tab to bring up the dialog box shown in Fig.1,

Fig.5 (below): this is the window that appears when you launch the Registry Editor. Be sure to back the registry up first before making any changes, as the registry is vital to the operation of Windows 95.



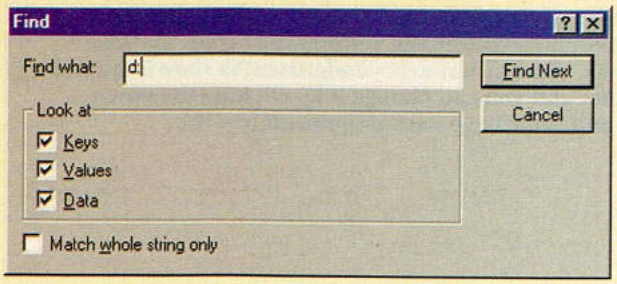


Fig.6: you can search for all occurrences of D: in the Registry by pressing CTRL F to bring up the Find dialog box.

then Double click on the CD-ROM option. The CD-ROM option will expand to show your currently installed CD-ROM (Fig.2).

(3) Click once on your CD-ROM and then click the Properties button. A new box will open and you should now click the Settings tab to bring up a box similar to that shown in Fig.3.

(4) Towards the bottom of this box, you will see a section which shows the current CD-ROM drive assignment and just below that some settings for reserving a drive letter. At this stage, the latter will probably have no assignment selected.

To select an assignment, click on the Start Drive Letter down arrow. A list of available assignments will now appear. Select a new assignment (R: is always a good drive letter assignment for a CD-ROM drive) and the End Drive Letter will automatically select R: as well.

(5) Click OK to close the dialog box and save the new assignment, then click OK on the Device Manager box to close it. You will now be prompted to reset your computer so that the new changes will work.

Let's hack the Registry

Now that we've assigned a new drive letter to the CD-ROM, let's open the Registry Editor. There is no shortcut to the Registry Editor on the Taskbar, so we must launch it using the Run command. To do this, click the Start button, select Run, type Regedit and press return (Fig.4)

The Registry Editor will load and you see a window just like that shown in Fig.5.

Now select (highlight) My Computer and press Ctrl F for the search engine. A window like that shown in Fig.6 will pop up and you should then type in D: and click the Find Next button. It will now go through the Registry and find any occurrence of D:.

Be careful, because it will also find other values that match this criterion such as Dword:

It is wise not to set the search up so that it only matches the whole string because it can miss some setup options. Searching for D: should locate both D: and D:/, as well as D:/progra~1 and so on.

This sounds easy and it actually is. All you really have to do is think about what you are changing.

In order to make the actual changes, you utilise the right click option on

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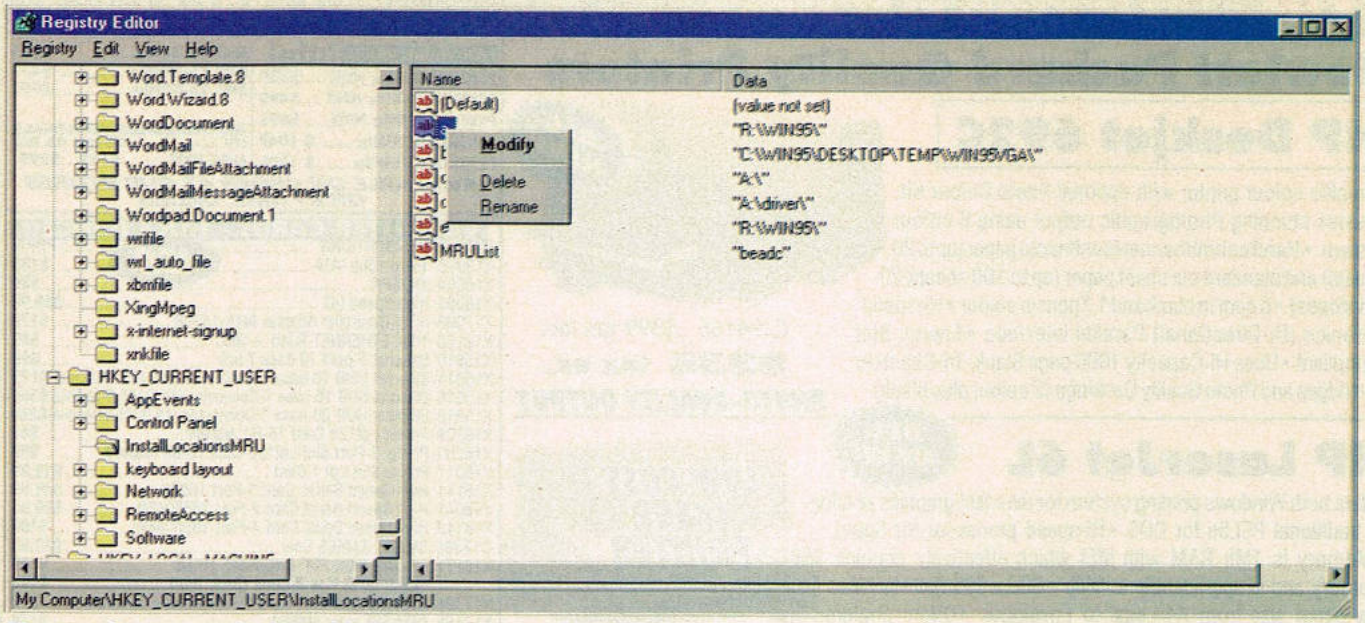


Fig.7: each time you find an old drive assignment (ie, D:), right click on the name and then click Modify so that you can make the necessary changes to the Data.

the mouse. Each time you find an old drive assignment, you right click on the Name and then left click on Modify so that you can make the necessary changes to the Data. To change the Name (should that also be incorrect), you select the Rename option – see Fig.7.

Do not make any other changes except to the drive assignment, as changing the path will cause problems that can only be corrected by reinstalling the affected software.

Once you have made the necessary changes, click the Find Next button (or press F3) to automatically search for the next occurrence of D:. Once all the changes have been made, you can then check for any missed assignments by highlighting "My Computer" and pressing F3 to initiate a complete new search from the top. This may take a while to do as the Registry can be quite large.

When all is done, check it out by loading your favourite CD-ROM based game and see if it works. Most programs should run fine but remember to check out your System.ini and Win.ini files for programs that were written for Windows 3.x and edit any path entries accordingly. You should also inspect any .ini files that are specific to those programs and edit these if necessary.

If a program still refuses to work, then reinstall it and everything should be OK. Saved game points should still be there as will all your important documents. The changes we have made only affect the programs themselves and not your saved data. **SC**

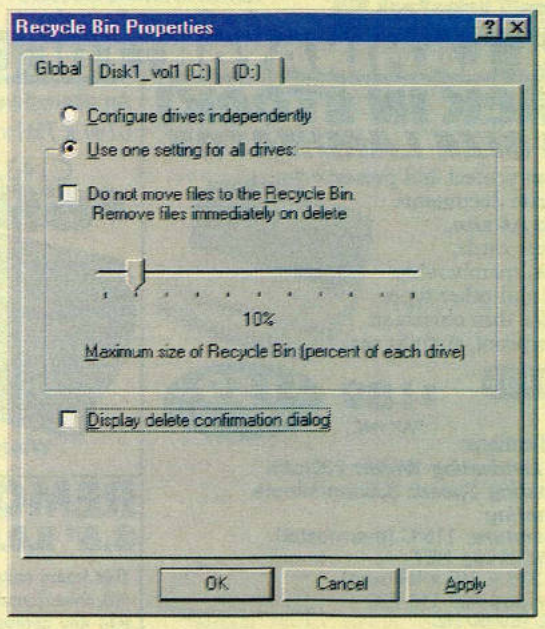
Tip: Send Files Straight To The Recycle Bin; Do Not Click "Yes" To Confirm

Sick of clicking "yes" in the confirmation box that pops up each time you press the delete key or drag files to the Recycle Bin? Then turn it off.

To do this, right-click the Recycle Bin and click Properties from the resulting drop-down menu to bring up the dialog box shown in Fig.8. Now clear the "Display Delete Confirmation Box" option and click OK to close the box.

Now when you delete files, they will go straight to the Recycle Bin. Don't worry about deleting the wrong stuff because it is all in the Recycle Bin and can be retrieved if necessary until the bin is cleared. You will still be prompted if you want to delete an applications (*.exe) file, however. This is because application files are considered more important than others.

By the way, you can also use the Recycle Bin Properties dialog box to set the maximum size of the Recycle Bin (as a percentage of disc size). If you have two hard disc drives, you can either use the same percentage for both or set them independently.



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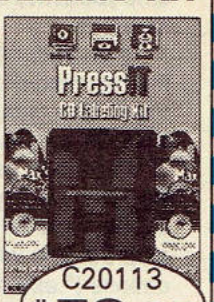

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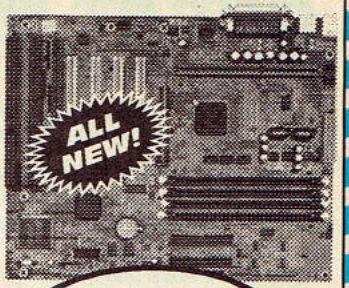

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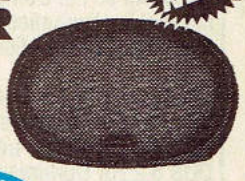

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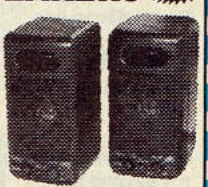

Budget stereo computer or regular amplified speakers. Magnetically shielded. Can be used as powered/ amplified speakers. Independent control for each box. With Bass boost circuit. Features paper cone with silver dust cap. Voume controls and single aux input. Lightweight and portable.

C10196 **$39.95**

Specifications:

- 10 watts PMPO per channel 10% THD @ 4Ω •87mm driver •Input signal: Aux is 300mV •Requires 6VDC 300mA or 4 x "C" size batteries.

PARALLEL AUTOMATIC 2 WAY

- Allows 2 computers to share one printer or 2 printers to be selected from one computer
- Simple switch selection to change mode
- A, B --> C selection or A --> B, C selection
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X19154 **$119.95**

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X19153 **$34.95**

- Automatic two way
- Allows two computers to share one printer
- Compatible with most printers
- No external power/ software required- powered by computer

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LI5055 **$69.95**

Amplify up to 16 TV's

The POWER LINK adapted from the UK design for Australian requirements, provide an easy antenna signal splitting and amplification system. It comprises of two outputs: -One for high gain for amplifying a weak signal to 1 to 4 tvs or distributing an average signal to 1 to 16 tvs. -The other output is for low gain for feeding a tv in normal areas or for feeding another POWER LINK for another system up to 16 tvs.

- This unit can be used in a couple of different ways: Amplifying/distributing TV and if needed FM radio signals and or distributing video/Satellite/Cable TV as well as an FM radio
- Simple modular connectivity make this system a snap to install and expand when required.

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- Round insertion holes for flexibility- allowing easy insertion of various components from resistors to chokes.
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- Units can be further expanded in size by simply snap-fitting in another section for a larger circuit.
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- Each distribution strip provides 4 section of positive voltage terminals.

BREADBOARD KIT-970 HOLES

P11020 $29.95

Breadboard:
- 970 tie points
- 140 x 70mm
- 1.6 mm aluminum plate
- 1 distribution strip
- 1 terminal strip

Components:
- 4 binding posts
- 5 pads
- 140 jumper wires
- 6 adhesive

BREADBOARD KIT-3220 HOLES

Breadboard:
- 3220 tie points
- 140 x 70mm
- 1.6 mm aluminum plate
- 7 distribution strip
- 4 terminal strip

P11024 $59.95

Components:
- 4 binding posts
- 5 pads
- 140 jumper wires
- 5 adhesive

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SPECIFICATIONS 400 WATT P.M.P.O.

RMS: **subwoofer:** 22W per channel, **satellites** 10W per channel

Acoustic output (max.SPL@1M)98 dB

Frequency response:30 Hz-20 KHz

Drive unit:subwoofer powerful 5" **subwoofer**

Satellite:3" full-range

Dimensions (WXDXH):
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K10860 $8.45

ALL NEW!

PHONE CONTROLLED REMOTE POWER SWITCH

When connected to a modem, this low-cost project will activate its 240V AC outlet when a pre-determined number of rings occur on the phone line. Dubbed the Remote Power-up, it's ideal for communication sessions between PCs where the remote "host" is normally off- a far more secure way to leave an unattended PC and its valuable data. The unit has an automatic or manual shut-off feature, is easy to build common off-the-shelf parts, and can be used for a range of other remote power control tasks. ***Jumper box is included. EA JUN'97***

K10845 $64.95

ALL NEW!

LOW COST SIMPLE WAVEFORM GENERATOR

This compact unit produces both square and triangle waves over the frequency range from 100Hz to 20KHz. Build it and use it to test audio amplifiers, filters, tone decoders and digital circuits. ***SC Jul '97***

ALL NEW!

K10855 $21.25

INTERIOR LIGHT DELAY FOR VEHICLES

ALL NEW!

Fit this project to your car and the courtesy lights will stay on for an extended period after the door is closed, then fade out gracefully. It's small, low in cost, can be installed without cutting any existing wires, and can be configured to suit virtually any cars. ***EA APR'87***

K10830 $8.45

POINT CONTROLLER FOR MODEL RAILWAY

Most model railway enthusiasts operate their points with a twin solenoid connected to a 15V supply. However, if you keep your finger too long on the button for just a moment too long, you can easily burnt out the solenoid coil. This point controller avoids that problem. **SC Jul '97**

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THE MINISTROBE: USING THE WHITE LED

This little project take advantage of the White LED's bright white light, its high efficiency and fast response time. The Ministrobe can effectively "stop the motion" of almost anything running from 400 to 4000rpm, such as electric motors, car engines, electric mixer. ***EA Aug '97***

ALL NEW!

K10870 $24.45

MANUAL CONTROL CIRCUIT FOR A STEPPER MOTOR

This ciruit will give you manual control of a stepper motor in one direction or the other. It will have a variety of applications and a demonstration is included to show how it could be used to control a model railway boom gate. Motor is not included. ***SC JUN'97***

ALL NEW!

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Do away with analgesics and alleviate pain electronically with a TENS Unit. This produces pulses of current into electrodes placed on the skin adjacent the painful area and has a success rate on most sufferers. The TENS unit provides the necessary features and is considerably cheaper than commercially available units. ***SC Aug'97***

CASE MAY VARY

ALL NEW!

K10875 $71.95

5-DIGIT TACHOMETER

A highly flexible tachometer circuit that should cope with virtually any engine or rotating machinery. It has a crystal timebase and a resolution of one rpm.

ALL NEW!

K10900 $106.45

AUDIO FREQUENCY SHIFTER

Here's a new low cost design for a unit which can be of great assistance in controlling feedback ("howl-round") in public address and other sound reinforcement systems. It operates by shifting the audio spectrum by 5Hz, and features a very low noise and distortion over a full 20Hz to 20kHz bandwidth. ***EA Aug '97***

SHORT FORM

ALL NEW!

K10865 $82.45

TRAFFIC LIGHTS FOR AN INTERSECTION

Most model railway layouts have a few roads winding their way around and often a small town with an intersection is included. A good way to add life to such a scene is to have working traffic lights at the intersection. **SC MAY'97**

K10835 $18.95

FLICKERING FLAME

This little lighting gimmick was used by the dozen at a recent school eisteddfod. It uses a 12V 20W halogen lamp/reflector fitting mounted in a plastic drink bottle filled with red cellophane. A group of these gives a convincing imitation of fire, hence the name "Flickering Flame". SC Sept'97

ALL NEW!

K10910 $20.75

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POWERED BY INTEL® PENTIUM™ 200MHz

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5.1 GIG H.D.D.

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The ideal system for today's power-hungry users...

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3.2 GIG H.D.D.

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- ★ Windows 95 104 Keyboard
- ★ 16-bit Sound Card -SB compatible
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BassBox software: where do you get it?

I was really interested in the Bass Barrel subwoofer described in the August 1997 issue of SILICON CHIP. In particular, I'm interested in the BassBox software. Can you tell me who distributes it in Australia and how much is it? (P. T., Rutherford, NSW).

• The distributor for BassBox software is Earthquake Audio, PO Box 226, Balgowlah, NSW 2116. Phone (02) 9949 8071; fax (02) 9949 8073. We reviewed the BassBox 5.1 software in the June 1996 issue of SILICON CHIP. Back issues are available at $7 each including postage.

By the way, we have had a number of enquiries wanting to know if we have published a subwoofer amplifier and the answer is no. But we did publish a subwoofer controller in the December 1995 issue (as mentioned in the article) and that could be teamed with virtually any power amplifier. On the other hand, if you wish to use the Bass Barrel in a Dolby Pro-Logic Surround Sound system, you don't need a subwoofer controller. Just hook the subwoofer power amplifier's input to the subwoofer output on the decoder (or Dolby receiver) and you're ready to go.

While we are on the subject, some readers have discussed the Bass Barrel with hifi dealers and have been told that it would be not satisfactory because it was not an "active" system. In fact, when the Bass Barrel is teamed with its own power amplifier, it is an "active" system.

Stabilising a 12V supply

My house is on a 12V DC system and wherever possible everything runs on 12V except power tools, for which I use an inverter. The problem arises with items like a laptop computer. Now it is possible to use the inverter with the 240VAC adaptor but at the lower loads of a laptop, say 20-30W, the use of a moderately large inverter (660W) at such a low load is inefficient. In effect, the consumption at the battery system is a lot higher than the 20-odd watts of the laptop.

I do have an old Toshiba 286 which fortunately runs off 12V DC. However, whilst at first glance it seems my troubles are over, in reality they're not. The battery bank voltage can fluctuate throughout the day and night. By day as the battery comes up to charge, the voltage may reach 13V. And at night as lights and the laptop drain the system, the voltage begins to fall.

It is not unusual for the system to crash and keyed-in text is lost if not stored on the hard disc. The problem is therefore twofold, to produce a variable DC voltage in the range 12-24V DC, and second, to achieve a stable supply. Can you help? (R. O., Wittenoom, WA).

• To stabilise your 12V supply, we suggest you try the 2A SLA battery charger published in the July 1996 issue. It may be advisable to connect a 1000µF 16VW capacitor at the output as well.

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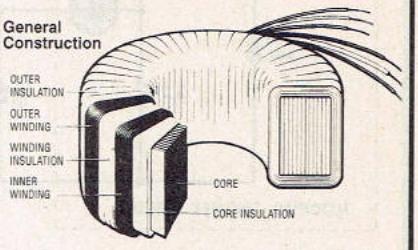

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Pros & cons of high voltage transistor

I am writing with an enquiry about the High Energy Ignition described in the May & June 1988 issues of SILICON CHIP. Is it possible to use a standard 2N3055 power transistor instead of the very expensive MJ10012? The current rating is nowhere near that of the MJ10012, however, from what I can work out, the current through the primary circuit never comes anywhere near this, probably more like 1A rather than the 15A of the MJ10012.

The back EMF may be a problem however more of the zeners should alleviate this problem. Also to increase the spark duration can I just change capacitor C1? (A. M., Bayswater, Vic).

• The 2N3055 is completely unsuitable for an ignition system. The peak current through the coil can be expected to be around 5A while the peak voltage is limited to 300V by the four 75V zener diodes. These conditions are far in excess of what can be handled by a 2N3055. We understand that the MJ10012 is normally fairly expensive but you can presently buy it from Rod Irving Electronics at $7.95.

We do not recommend that you modify the circuit in an attempt to increase the spark duration. This is a function of energy storage in the coil and since the circuit has dwell extension, no effective increase in duration can be obtained.

Expansion in amplifier heatsink

I am very enthusiastic about your new 500W amplifier as described in

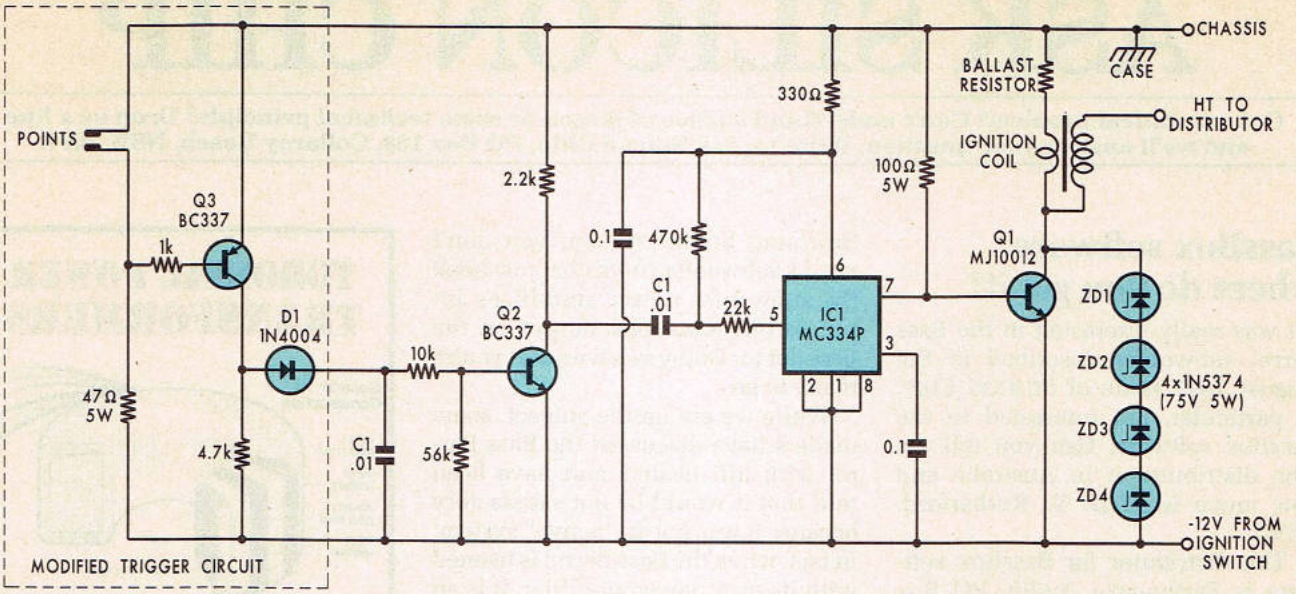

Fig.1: this modified circuit of the High Energy Ignition System is suitable for use with cars that have a positive earth electrical system. The changes are to the trigger circuit.

High energy ignition for an old Jaguar

I have constructed and installed four of your High Energy Ignition kits with great success and satisfaction. They really are all they are cracked up to be.

A friend of mine with a 1947 Mark IV Jaguar asked me if I could fit one to his car, which has (+) positive earth. Is this possible? If not, would it be possible to modify the kit in some way? (P. T., Vaucluse, NSW).

• We assume that the car in question has a 12V battery and the existing ignition system does not have a ballast resistor. This should be the case for an English car of that vintage. That being the case, it should be a straightforward matter to adapt the circuit of the High Energy Ignition system. In effect, the positive side of the circuit goes to the case, to match the car's electrical system, and the negative supply comes from the ignition switch.

However, the points themselves do present a problem because they pull the points input high, instead of low, as for a negative-chassis car. The solution is to add a PNP transistor to invert the points switching signal. The accompanying circuit (Fig.1) should do the job. The extra components can be fitted on the existing PC board; there is vacant position for a transistor.

the August, September & October 1997 issues. I have purchased all 28 bipolar transistors and am currently sourcing the other components. I may be wrong (please forgive me if I am) but to have the 14 bipolars terminated so close to the PC board and secured to such a long heatsink, I feel that at above 80°C the thermal expansion of the heatsink may want to place the bipolar transistors at a greater pitch (and something has to give) and damage the solder joints to the PC board or the transistors themselves.

Just a thought, but should the full length of transistor legs be used or perhaps flying leads to the transistors? (L. L., Carrum Downs, Vic).

• The potential problem lies in the differing coefficients of expansion of the aluminium heatsink and the copper laminate of the PC board. The practical temperature range to be considered is about 70°C, say from 15°C ambient to about 85°C, by which temperature the thermal cutout should have operated to disconnect the load. If you then take the difference between the coefficients of expansion of aluminium and the PC board and allow for quite effective heat transfer via the transistor leads to the PC board, the differences in expansion for the worst case transistor (at the extreme ends of the heatsink) should be no more than about .07mm.

Given that the transistors have single hole mounting which does allow for some movement, we are inclined to the view that there is not a problem. Of course, if readers are concerned, they can increase the lead length of the transistors to allow for a little more compliance.

We strongly recommend against increasing the lead length by using flying leads as it might result in supersonic oscillation.

Drift in the FM Stereo Transmitter

I need your help please with the FM Stereo Transmitter, as described in the October 1988 issue of SILICON CHIP. The problem is that it "drifts" off station, either over a period of five minutes or an hour or simply after switching off and then back on again. I then have to readjust either the L1 or L2 slug or both.

When I first switched on and checked the voltage across pins 3 & 15 and then started adjusting the slugs (with a plastic screwdriver), I found that "breathing" on the 1.5 turns of copper

wire would upset the adjustment. I then "fixed" the turns with a dab of nail polish. L1 is very touchy; L2 takes maybe only 1/16 turn to reset. As I only need to "transmit" over about three metres I used the single wire antenna but even so it works well over 20 metres. (K. C., Balgownie, NSW).

• The drift in frequency of transmission is probably due to the capacitance change of the tuning capacitors with temperature.

Make sure that the 47pF capacitors across L1 and L2, the 15pF capacitors on pins 9 and 10 and the 4.7pF capacitor at pin 10 are NPO types. These will be labelled "NPO" or with a black dot. NPO stands for "Negative Positive Zero". This means that the temperature coefficient of capacitance is zero for the normal operating temperature range.

You can expect to affect the tuning when the antenna is held with your finger and thumb. This is because it alters the capacitance of the tuned circuit.

Don't overdrive the Bass Barrel

I intend to construct the Bass Barrel Subwoofer from the August 1997 issue but I need further information. Firstly, what is the power requirement to drive this unit? Also what is the maximum (safe) power the unit can handle? Can you recommend a suitable amplifier kit? What passive low-pass filter could be used in place of the active one briefly alluded to in the article? Thank you. (G. P., NT).

• The specified woofers have a maximum rated power input of 75W and since they are in parallel, the Bass Barrel would have a nominal maximum input power of 150W. However, we do not think it would be safe to drive them at these high levels for anything more than a brief interval otherwise you run the risk of blowing them. In fact, we have heard of a number of instances where people have done just that.

Note that this unit was originally designed for cars and is also suitable for small lounge rooms but if you use it in a large room and wind up the wick, you are bound to pay the penalty.

A suitable amplifier module would be the 125/175W design featured in the April 1996 issue. This could be teamed with the subwoofer controller featured in the December 1995 issue of SILICON CHIP but remember our warning about winding up the wick. An alternative amplifier would be the 50W unit described in March 1994.

Alternatively, if you intend using the Bass Barrel in a Dolby Surround system, you could use the Dolby subwoofer output to drive the Bass Barrel amplifier.

Using a transducer with the speed control

I am interested in using the 12-24V Motor Speed Controller featured in the June 1997 issue of SILICON CHIP. However, I wish to use the output from a MAP sensor in a car to control the speed of a 12V fan. The MAP sensor has an output range of zero to 5V and I wish to obtain full fan speed when the MAP sensor output is 5V. Furthermore, I would like to introduce an adjustable offset, so that the MAP sensor might produce a voltage of say, 1.5V, before the fan operated. Can this wish list be achieved or is it all a dream? (G. B., Unley, SA).

• While we did not make provision for this sort of application it turns out to be relatively easy to do and just by adding one resistor. By connecting a 68kΩ resistor from your transducer to the pin 2 of IC1, the motor will have 12V applied to it, as set by VR1, for an input of 5V from the transducer. Furthermore, the initial offset will be 1.5V, so the effective input range is from 1.5V to 5V.

By changing the resistor to 100kΩ, the offset can be reduced to 0.3V and if you reduced the resistor to 47kΩ, the offset is increased to 2.5V.

Notes & Errata

Flexible Interface Card, July 1997; Stepper Motor Controller, August 1997; and PC Card For Two Stepper Motors, September 1997: in the circuit of each of these boards the resistor from pin 4 of IC1 is shown going to ground. This is how the PC boards will be supplied. The resistor should go to the +5V supply, which is pin 16 of IC1. On each board it is quite simple to move the ground end of the resistor to the positive supply after drilling one hole.

If you are only using a single board this may not be a problem, although we do suggest that you move the 10kΩ resistor so that it is wired between pins 4 and 16.

The problem shows up when you are using several cards with different addresses on the same printer port and start changing these addresses.

Low Dropout 5V Regulator, Circuit Notebook, October 1997: This circuit has the emitter and collector of Q1 reversed. The emitter should go to the +9V supply and the collector should connect to the 5V output. **SC**

WARNING!

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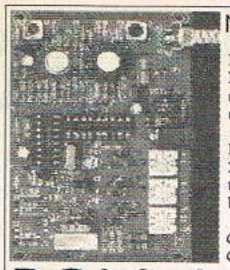

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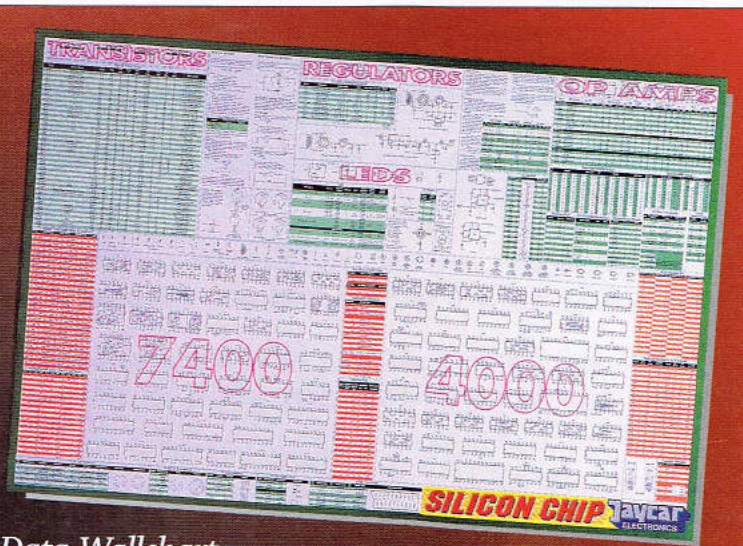

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